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INDUSTRIAL ENGINEERING
EDUCATION AND TRAINING

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THE NATIONAL SHIPBUILDING RESEARCH PROGRAM

Application of Industrial Engineering Techniques to Reduce Workers' Compensation and Environmental Costs

U.S. DEPARTMENT OF THE NAVY
CARDEROCK DIVISION,
NAVAL SURFACE WARFARE CENTER

in cooperation with

National Steel and Shipbuilding Company
San Diego, California

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THE NATIONAL SHIPBUILDING RESEARCH PROGRAM

PANEL SP-8 INDUSTRIAL ENGINEERING

Report Number 0526

APPLICATION OF INDUSTRIAL ENGINEERING TECHNIQUES TO REDUCE WORKERS' COMPENSATION AND ENVIRONMENTAL COSTS

SUBMITTED BY:

NATIONAL STEEL AND SHIPBUILDING COMPANY
SAN DIEGO, CALIFORNIA

In Cooperation with:
Gulf Coast Region Maritime Technology Center
University of New Orleans
New Orleans, Louisiana

TABLE OF CONTENTS

EXECUTIVE SUMMARY

This report outlines the objectives, findings, strategies and limitations of the project; "Application of Industrial Engineering Techniques to Reduce Workers' Compensation and Environmental Costs". This research was undertaken by National Steel and Shipbuilding Company on behalf of the National Shipbuilding Research Program's, SP-8 Industrial Engineering Panel.

The research was divided into eight tasks. Three had sub tasks attached to each of the major tasks. Each task was approved and funded separately. The primary focus was the utilization of Industrial Engineering expertise to provide a safer work environment and reduce costs for workers' compensation and environmental operations. The tasks were:

- **Task 1.0 Project Team Definition**
- **Task 2.0 Establish Complete Project Scope**
- **Task 3.0 Implementation of Task 2.1 In The Selected Areas**
- **Task 4.0 Implementation Of Task 2.2**
- **Task 5.0 Implementation of Task 2.3**
- **Task 6.0 Implementation of Task 2.4**
- **Task 7.0 Conduct Workshops**
- **Task 8.0 Final Report**

To ensure success with the project, the research needed to be performed at the lowest level in the organization. It was discovered that employees at this level in the organization were competent enough to assist with research, testing of recommendations, analyzing data and implementing suggested changes.

The principle findings of this research project generated significant cost savings, improved equipment for Electrical and Paint & Blast, increased safety and morale in the departments and encouraged employee implementation of findings. First, Paint & Blast saved over **$1.2 million** dollars on workers' compensation costs in 1997. This represented an eighty-seven percent (87%) decrease in repetitive motion injuries, with an additional reduction of fifty-five percent (55%) in the department's highest injury area, On-block. The department's eye injuries decreased 4.59% in 1997, and as of June 1998, there have not been any workers' compensation cases. The utilization of full-face cartridge respirators contributed to the reduction of eye injuries, also a reduction of set-up times by 30 minutes per employee and reduced further possibilities of injury by limiting the number of air lines in confined areas.

Second, the Steel Erection areas back injury rates decreased from forty-two percent (42%) in 1996 to 4.8% currently. The number of back injuries decreased from ninety-two in 1996 to nine as of May 1998. Due to the level and amount of training, safe behaviors increased from fifty-one to seventy-one percent (51% - 71%). The cost savings realized were over $92,900.00 in 1997 and a projected $81,700.00 in 1998.

Third, the Electrical cable crew injury rate decreased from 18.2% to 2.4%, while the overall departmental rated decreased from 2.45% to 0.5%. By purchasing a cable puller, four employees were eliminated from physically pulling cable. This machine has a projected cost savings of $801,000.00 per machine per year, with a reduction of over 22,000 man-hours per machine. In 1997, cost savings of $219,720.00 were generated and the projection for 1998 is over $24,889.00.

Fourth, the Steel Assembly area injury rate decreased from 70% to the current rate of 39%, due to training in Behavioral based safety. 387 employees were trained along with, 36 supervisors.

The acceptance of the findings presented here is largely determined by the credibility of the interpretation of injury statistics, actual incurred costs paid by NASSCO's Workers' Compensation Department, as well as observation and analysis of the Project Engineer and Process Improvement Teams. We strove to minimize errors of omission of critical data, and where possible, we tested our findings against data from outside sources to assist in completion of our analysis.

The results presented in this report, represents the best possible understanding of ways to reduce workers' compensation and environmental costs at this time. The wealth of resource knowledge presented here supports Behavioral based safety, Organizational Culture and NASSCO's mission, vision, goals and the results of this project illustrate a commitment to reducing occupational injuries. The processes and procedures utilized by the different teams represent a base model for any organization to emulate. The financial savings demonstrated, in this report can be increased or decreased based on an individual organization's commitment to the safety, health and well being of their employees.

DELIVERABLE A

PROJECT TEAM DEFINITION AND ESTABLISHMENT OF PROJECT SCOPE

PROJECT TEAM DEFINITION

In establishing the Safety Improvement Team to define the project scope, representatives from the following areas were required in addition to the Project Manager and Project Engineer: Training, Safety, Workers' Compensation and Production. The Production representatives were selected from areas of the shipyard where there had historically been problems with high injury rates or high severity rates.

Also, it was desired that the representative be a member of management so the team would have the authority present to make necessary authorizations and changes. The Safety Process Improvement Team was then formed based on the above and consisting of the following members:

NAME	POSITION
Eric Murray	Controller (Risk Management & Workers' Comp)
Jim Paulson	Manager Safety
Brienn Woods	Manager Training & Development
Judie Blakey	Superintendent Paint, Blast & Ways
Bob Hillstrom	Manager Steel Erection
Dave Langenhorst	Superintendent Electrical & Electronics
Fred Hogan	Project Engineer
Tom Fawcett	Project Manager

ESTABLISHMENT OF PROJECT SCOPE

The Safety Process Improvement Team's basic philosophy in developing the project approach was to develop a pilot process and methodology for managing a shipyard safety program which would apply to any shipyard. Thus, the project approach suggested in the abstract and in NASSCO's original project proposal was reevaluated against that criterion. The project team felt that the abstract approach to the project would generate a one time benefit without establishing a lasting process for successfully managing shipyard safety programs.

Based on that premise, a different approach was taken to accomplishing the project objectives. The basic premise of the project approach was that the hourly production workers had to be intimately involved in order for any safety program to be successful. Two primary methods of hourly employee involvement were selected for pilot approaches to managing safety.

The first approach was the establishment of Safety Process Improvement Teams in selected work areas composed of hourly workers plus some salaried supervision. A facilitator from either the Training Department or the Safety Department was provided to each process improvement team. Also the Project Engineer was a member of each of the process improvement teams. The premise of this approach was that the hourly production workers in the specific areas knew best what the safety risks were in their work area. The Project Engineer was involved to help facilitate the group and to help implement solutions to either eliminate or mitigate the risks. These might come in the form of changes in the tools used in the production work area, adding or changing personal protective equipment, changes in the production process itself, or other factors. The production work areas selected for the pilot teams were the work areas of the production members of the Safety Process Improvement Team: Paint & Blast, Electrical and Steel Erection. They were selected because these were areas of either high frequency of injuries or areas of potential high severity of injuries. Also as the heads of these areas were already participating on the Safety Process Improvement Team, the management of these areas was committed to implementing the pilot teams.

The Blast and Paint Process improvement Team decided to look at three areas. Phase I will look at upper extremity injuries. Results of this study will be published in Deliverable B. Phase II will look at eye injuries with results to be published in Deliverable C. Phase III will look at Environmentally Compliant Spray Equipment with results to be published in Deliverable D. The Electrical Cable Pulling Process Improvement Team selected back injuries occurring during the cable pulling process. Their results will be published in Deliverable E. The Steel Erection Process Improvement Team selected back injuries. The results will be published in Deliverable F.

The second approach was the implementation of a behavioral safety program in a pilot area. The behavioral safety approach consists of extensive training of the work group and the initiation of peer observations in order to get to the underlying cause of accidents: Unsafe work behaviors. The Steel Assembly area was selected for piloting this approach, primarily because it was an area where there was a high frequency of injuries and a potential for high severity of injuries. Results from this task will be published in Deliverable G.

The end result of this project will be a guide to implementing a model successful safety program in a shipyard using a combination of hourly production worker involvement, training, and process modification and improvement using industrial engineering techniques.

In developing an approach to reducing environmental costs, the Environmental Engineering Department was consulted as to using a similar approach to eliminating or mitigating environmental costs. Their perception was that before this approach could be implemented, that there were data system issues and training issues that needed to be addressed. In particular, a major problem in all shipyards was an inadequate hazardous material tracking system. Therefore, a small percentage of the budget (5%) was allocated to the development of a hazardous material tracking system which could be used at shipyards throughout the country. Results from this task will be published in Deliverable H. Also, there is a consensus need for interactive training software to provide required environmental training on an individual basis with minimal impact on production schedules. A small percentage of the budget (5%) was allocated to developing this training software. Results from this task will be published in Deliverable I.

In order to accomplish the project objective of sharing knowledge obtained through the research conducted under this project scope, a series of yard visits are planned to disseminate project items of particular interest to a particular shipyard. Also, a series of workshops will be presented highlighting key project results and recommendations. Results from this task will be published in Deliverable J. Finally, a comprehensive final project report will be prepared for distribution to all interested parties. Results from this task will be published in Deliverable K.

DELIVERABLE B

PAINT AND BLAST UPPER EXTREMITY INJURIES

Table of Contents

SUMMARY

The mechanical cleaning process is a major aspect of the painting process and therefore had to be considered part of the injury prevention process. The actual surface preparation processes were observed in a number of process areas such as, in the On-Block areas, Blast pit operations, Ship board operations, Sub-assembly areas, Sheet metal shops, to determine exposure to power tools. It was noted that according to the skill level of the Painters, techniques in the use of power tools were completely different. The different body positions, in the aspect of how they held the tools to perform mechanical cleaning operation, were interesting, in that, there was no universal technique. The following factors such as, size of the units, areas of difficulty, contour and shape, contorted positioning, etc., were all taken into consideration during the observation period. Due to the nature of work in Blast and Paint, certain positions for mechanical cleaning were unavoidable.

During the observation process, Painters were observed using more 15 degree angles for mechanical cleaning than actually required. When using the standard 15 degree angle for mechanical cleaning, you subject the wrist to pain and injury. When using unnatural wrist positions, it was noted that more pressure was exerted on the hand, arms, elbows, and especially the shoulders. Most of the Painters in the production areas, where mechanical cleaning was performed, were observed using unnatural or cramped positions for mechanical cleaning.

Nearly all Painters use wire wheels to perform SP-3 and SP-11surface preparation requirements. The use of wire wheels posed other problems in regards to injuries, such as wires becoming dislodged from the bristles, and the weight of wire cups.

Another observation noted was the average ages of the Painters and Blasters. **(see appendix, sec.b.chart b-1).** This was noted because age could have been a factor in contributing to the injury rates. The Blasters and Painters injury rates for ages thirty-two to forty-four years were higher. During these years the employees are more mature, but it could be possible that unnecessary risks were taken to perform job functions.**(see appendix, sec. a, charts a-1 to a-3, also sec. b, chart b-1).** It is also of note, that this age group is mentally more mature, their years in Blast and Paint range between one and seven years. **(see appendix, sec.c).**Incidentally this experience level between one and seven years were the most injured group in Paint and Blast.**(see appendix, sec.c)**

Gloves were also examined as possible contributors to hand and finger injuries. During the average production shift, standard issued thin cotton gloves are used for the workers' hand protection. During the winter months, these employees complained that the gloves were not sufficient to protect them from the cold air exhaust of the grinders and buffers. During the normal operation of the these air tools, excess air is released across the operators hand. Another problem noted was, the formation of ice on the tools during winter months. These particular gloves caused the workers' hands to literally become glued to the power tools during the periods when ice formed on the tools. This caused cumulative trauma disorders of the fingers or "white finger syndrome". One final note about these gloves, is that they were of little use for vibration protection for the user.

The final aspect of the observation process included the use of power tools themselves. Before the new requirements and procedures for mechanical cleaning were introduced in Paint and Blast, heavier tools and abrasives were needed to meet surface preparation requirements. When the new processes went into effect, the tools were not modified to meet current needs and therefore using these tools allowed the user to "over perform" mechanical cleaning. It was noted that the old tools, the" cleco brand", weighed and average of seven pounds plus the addition of a wire wheel or cup which added another pound. The weight of these tools posed problem for most of the physically challenged(smaller) operators. Employees using these tools for mechanical cleaning of areas such as, overheads and bulkheads were observed to be having frequent rest breaks, due to fatigue.

BACKGROUND

In 1994 the Paint and Blast department began the transition from blasting A-2 units to mechanical cleaning and painting. Due to this change in processes, the requirements for mechanical cleaning gradually increased. The former process entailed blasting off preconstruction primer and repainting before erection. During this period, NASSCO went exclusively to Nippe Ceramo preconstruction primer. This was approved for usage on the current construction contracts without having to remove it, prior to applying the first coat of the system.

The pre-erected units (A-2's) went directly to the Paint Department upon completion by the outfitting trades. It was during this period, when the injuries began to escalate in the On-block area and Paint department as a whole. The Blasters, because of work shortages, began to be utilized in the On-block (outfitting) area to perform mechanical cleaning. They too began to experience trauma type injuries. Lost time injuries and first aid injuries in regard to cumulative trauma disorders were being frequently diagnosed by the medical department in 1995 and 1996. **(see appendix, see.sec.e, and sec.d, chart d-3)**

The new requirements for surface preparation was a SP-3, which is to remove all loose and unadhering rust and SP-11, which is to remove all traces of rust, whether adhering or loose. The SP-3 and SP-11 standards, which are universal in the marine industry for surface preparation, may not have seemed on the surface as major contributors to hand, wrist, shoulder, elbow and finger injuries. However upon further observation, reviewing injury data and injury investigations, the main causes centered around gloves, power tools and physical conditioning. **(see appendix, sec.d, chart d-2)**

PARTICIPANTS

As a result of escalating injuries and worker compensation costs **(see appendix, sec. j chart j-4)**, Ms. Judie Blakey, Paint and Blast Department Superintendent, formed a Process Improvement Team to combat these issues. As a result of her efforts the following personnel was assembled because of their expertise and knowledge, to solve the workers compensation and injury issues. Everyone in connection with the team, has extensive knowledge of the processes and procedures of the Blast and Paint Department.

To keep the team focused on the goals of the project, a charter was established. The charter stated that, a PIT (Process Improvement Team) was established to study the causes of hand, wrist and arm injuries within stages of construction Three and Five from mechanical cleaning by Blasters and Painters. Solutions will be recommended for implementation through a pilot program. From anticipated positive results of this pilot program a permanent implementation program will go into effect.

Name	**Job Title**	**Department**
Andre Dorais	Facilitator	Training
Indy Parra	Production Supervisor	Paint & Blast
Bobby Flores	Production Supervisor	Paint & Blast
Jim Ferguson	Industrial Hygienist	Safety
Arthur Green	Production Supervisor	Paint & Blast
Tony Robinson	Corrosion Control Specialist	Paint & Blast
Mario Cosio	Ass't Superintendent	Paint & Blast
Judie Blakey	Superintendent	Paint & Blast
Jim Paulson	Manager Safety	Safety
Craig Williams	Staff Engineer	Paint & Blast
Manuel Faria	Painter	Paint & Blast
Jorge Hernandez	Working Foreman	Paint & Blast

This team eventually evolved into the current team who consists of:

NAME	JOB TITLE	DEPARTMENT
Freddie Hogan	Staff Engineer	Human Resources
Andre Dorais	Facilitator	Training
Indy Parra	Production Supervisor	Paint &Blast
Bobby Flores	Production Supervisor	Paint & Blast
Arthur Green	Production Supervisor	Paint & Blast
Tony Robinson	Corrosion Control Spec.	Paint & Blast
Carlos Loya	Production Supervisor	Paint & Blast

METHOD

A. BRAINSTORMING

The first meeting entailed setting the team charter, reviewing injury data and First Report Of Injury (FROI's). During that meeting and subsequent meetings following, a list of priorities was established. They came about as a result of brainstorming and filtering twenty three (23) ideas from the group, that met the problem statement. Several ideas were combined that were similar and as a result these were further narrowed down to the following five areas of priority.

1. Proper Gloves
2. Training
3. Tool Modification
4. Job Rotation within stages of construction Three and Five
5. Tool Selection

B. COURSE OF ACTION

After the team developed all priorities by weighted vote, the following course of action was suggested to solve the problem:

a. Commence exercise program within stages three and five for Blasters and Painters.

b. To reduce repetitive motion type injuries in stages Three and Five, rotate personnel to different job assignments.

c. Work with Fisher Safety to design a glove which meets the employees needs of comfort and fit, while at the same time addressing injury prevention

d. Have on order a number of wrist supports for a trial basis.

e. Research vendor information for vortex valves (heats up air prior to tool) for trial basis.

f. Involvement of Cleco Tool Company and other tool vendors to help design or modify tools with ergonomic considerations.

g. Detail study of mechanical cleaning process and potential alternative solutions, i.e. other tools, other cleaning methods.

C. INDUSTRIAL HYGIENIST RECOMMENDATION

The following course of action was recommended by the Team Industrial Hygienist:

1. Training involving pre-work stretching and intra-shift counter stretching: This is inexpensive and can be implemented immediately. Stretching leaders must receive training by Industrial Hygiene.**(see appendix, sec. f)**

2. Proper glove selection: The gloves are relatively inexpensive and can be used almost immediately. This is in his area of expertise and he desired direct input into glove selection.

3. Tool modification including paint container reduction: Five-gallon paint containers could be reduced to 2.5 gallon container. Other material handling improvements could be investigated. This would address one of the issues related to "material handling and related injuries". Tool modifications could take time both to design the modification, to work out the imperfections, and to install the changes.

4. Job rotation that involves two or more job changes per shift and which requires the use of different body postures and muscle groups: This will require management planning, but should not incur any material costs or significant production lost time. The purpose of job rotation for ergonomic relief is to spread the work stress to several major muscle groups over a single work shift. Posture changes and work changes will accomplish this. It is not sound ergonomic practice to institute job rotation that does not provide intra-shift relief from repetitive motion, strength requirements, and same or unchanged posture. Moving an employee to a new exclusive task every week, month, or longer can be harmful to the employee. Muscle groups will lose strength with inactivity and could be injured when the task is resumed several weeks or months later.

5. Tool selection: This the ideal approach if mechanical equipment could be found that could relieve the employee of the musculoskeletal stress of current work. This could be phased in to replace worn out equipment as a means of controlling expenses. Expect this to take time while the equipment is located, tested, and introduced to the work force.

Note: There is very little strength carry over from one muscle group to another so the act of grinding would not be expected to prepare the employee, strength-wise, for any other task.

TRAINING

A. EXERCISE PROGRAM

I. Stretching vs Exercise

Jim Ferguson commenced training with the Painters who were designated to lead group exercises. The employees were taught proper stretching techniques and the difference between exercise vs stretching, in short making the distinction. Stretching is best done when the muscles, tendons, joints, etc. are warm and have good blood flow. These tissues are more pliable or elastic when warm. You can run the risk of tearing or straining these tissues when they are cold and stiff. How do you overcome coldness and stiffness prior to stretching? In anticipation of stretching , move around, get blood flowing , move your arms, legs, and torso without challenging the limits of your range of motion.

It is not intended that this program result in vigorous movement of any type. It is important that individuals learn to "listen" to their bodies and to recognize when it is warning them against performing certain functions and when it is giving them permission to go ahead with an activity.

The body movements are to be gentle in nature. Body movements should be such that each individual gently tests the limits of their flexibility and range of motion with an **easy stretch.** After holding the easy stretch, test the body's willingness to go a fraction of an inch further. Only with the permission of their body should an individual extend the movements that bring an mild discomfort. This extended stretch is called the **developmental stretch.** Remember, the adages of "mind over matter" and "no pain, no gain" do not apply to us when stretching. **(see appendix, sec. f)**

Sensible stretching does not involve any "pumping" or "jerking" movement. We have all seen people do this. Those that do this type of exercise, (above mentioned) are simply using incorrect technique that will result in strains or sprains. If someone in the group has a injury or physical weakness, such as a slipped disc or pulled muscles that is healing or not yet healed; allow him or her to do movements that are light and do not impact on the injury, if the movements are not in contradiction to medical restrictions.

Caution your group about being patient. Caution the group against trying to get back flexibility and range of motion that was lost over many years in just one or two sessions. Flexibility and improved range of motion will come back, given enough time.

II. Stretching Movements

The attachment **(see appendix, sec. f)** shows drawings of those stretching movements recommended by NASSCO's physical therapist and Ergonomics Coordinator. The groups are limited to the exercises illustrated.

The drawings are shaded on those parts of the bodies that people can expect to feel stress. Again, beneficial stretching will impart a slight steady pull on the muscles involved. There should be no pain.

Stretching should be performed in two phases. The first phase is called the easy stretch during which the stretching movement goes as far as comfortable. The second phase is called the developmental stretch during which the stretching movement goes slightly beyond the comfort zone by a fraction of an inch or more. Pain experienced during any of the stretches means you have exceeded your stretch limits for you at this stage in your stretching program. If pain is felt during a stretch, ease off and back to an easy stretch.

B. POWER TOOL TRAINING

In order to properly train and educate all of the Painters in the use of pneumatic tools concerning their safe and unsafe usage, Norton Abrasive Company came in and performed the training. This class also covered the safe and practical use of abrasives too. In order to accommodate all employees in Blast and Paint, the classes were rotated over two days, with the class size on the average of twenty (20) per class. Twenty was chosen because retention rates may be better in smaller classes with fewer distractions. **(see appendix, sec. g, chart g-2)**

I. Topics Covered

Responsibility for proper use of portable grinding machines and wheels:
Machine Builder
Wheel Manufacture
User

Causes of Wheel Breakage
Type I Straight Wheels
Flanges not matched
Outer Flange Omitted

Substitute Flange
Outer Flange Reverse
Type 6 and 11 Cup Wheels
Type 16,17, and 19 cones and plugs
spindle too long
spindle too short
spindle not threaded far enough
flange design

Improper Speeds
slow speed wheels on high machines
High speed operation with low speed machines
lack of speed control
inadequate power

Abusive Operation
grinding on flat side of straight wheels
cramping of straight wheels
hard arching wheels

Careless Handling of Machine
dropping on floor, etc.
use of racks and hooks

Importance of Proper Machine Maintenance

Guards

Safety Standard Requirements
Type 1 wheels
cup wheels
type 27 and 28 wheels

Auxiliary Protection Devices
operator protection
safety guards
safety goggles and face shields
protective clothing

Work Area Protection
Barriers
Exhaust systems
Wheels Reinforcing
Fiberglass and filament reinforcing

Do and Don't Rules For Safe Portable Grinder Operation
The Three G's
guards
Goggles
Gloves

Fiber Discs Back Up Pads
correct size
no disc to disc
good condition
proper mounting

Acceptable Speed
fiber discs can be run at the rated RPM of the back-up pad
always use a back-up with the RPM clearly marked

C. GLOVES

Fisher Safety Company was contacted to provide samples of various gloves for testing. The gloves they provided were neoprene anti-vibratory, leather, reinforced cotton, nylon and rubber. Fishers manufacturer, Safeguard technologies further assisted us in our efforts.

I. <u>Selection Criteria</u>

Waterproof
Cold/Thermal insulation
Long life
Durability
Dexterity
Comfort/fit
Shock Cushioning
Non- slip surface

II. Glove Description

a. The performance combination, (neoprene and leather in three different styles, combines a synthetic leather palm that stands up to work with the warmth and shock absorption of neoprene. The unique palm design provides a secure gripping surface under all angles of stress. The performance combination offers minimum bulk and will not stiffen with wetting and drying**.**

b. The performance neoprene is an all neoprene glove that offers maximum warmth, comfort and pressure distribution. It is preformed into the shape of a flexed hand to minimize the effort required to hold objects. The sure-grip palm keeps the hand from slipping off the tools.

c. The performance neoprene lite combines neoprene and nylon for both shock absorption and unique high flexibility. It offers outstanding wearing comfort, exceptional all-weather insulating protection and extraordinary compression set. The high quality material provides superior abrasion resistance and durability. The worker wearing this glove will be able to grip firmly with its no slip palm.

III. Custom Design

After these gloves were tested in the On-Block area, the evaluation reports filled out by the Painters and Blasters were not favorable for further testing of the standard gloves (described above). Therefore we had Greg Baker from Safeguard Technologies, come in so we could design a glove that would fit our needs.

In the stages of design, we not only included selected criteria but added anti-vibe material to help reduce vibratory type injuries. **(see appendix, sec. h)**

It was at this stage in the design process, that the team enlisted the support of Therapy Specialist. Therapy Specialist is the company sub-contracted by NASSCO's Workers Compensation Department to perform physical therapy on our injured employees, and assist's in our Return to Work Program.

During this meeting with the glove manufacturer, Judi Coulthard, O.T.R, C.H.T, from Therapist Specialist strongly disagreed with him on what type of glove he thought we needed. She then gave essential input on what type of glove that would not only meet or exceed our criteria, but what was best from an ergonomic standpoint. Next an in-

depth discussion on hand safety, wrist supports, and proper glove selection followed. Major problems identified in wearing gloves can be resolved with proper fit. Gloves that are too thick, rigid, or slick may require more hand strength and consequently cause early fatigue. Gloves can interfere with dexterity or decrease circulation. One study reported that "gloves tend to increase the vibration level at low frequencies and decrease at high frequencies". Proper fit could avoid this tendency. Gloves should be selected to match the specific job. They should cover as little area of the hand as necessary to allow maximum effectiveness. They should minimize perspiration and distribute force to avoid pressure areas and not impair circulation or dexterity. Consequently, they should be tested for optimal thickness, flexibility, absorption, and force distribution. A variety of sizes should be available to accommodate the variety of hands.

The use of gloves in the workplace is controversial. Some of the benefits of wearing gloves are low cost of equipment, increased heat protection and increased ability to produce torque. Gloves designed for a specific job can increase performance. To minimize the incidence of trigger finger , padding of tools or hands to decrease forces could prevent neurovascular injuries.

The production team members designed the current glove from an assortment of samples received from the vendor. The final glove is a soft leather glove, double stitched around each finger, with anti-vibe material occupying the first joint of each finger, where the finger joins to the palm. There is no anti-vibe material in the thumb to prevent circulation restriction. The anti-vibe material was trimmed to about one eighth of an inch in thickness and it covers the complete palm area. **(see appendix, sec. g, chart g-1)**

ERGONOMIC DESIGN OF POWER TOOLS

I. Power Tools

It was recommended and noted during observations, that besides the need for new gloves, the power tool design needed to be resolved. From 1995 to 1996, power tool related injuries escalated and were the major contributor to lost time injuries in the Paint and Blast Department.**(see appendix, sec. g chart g-1)**

The most common risk factors of cumulative trauma disorders are repetitiveness, force, mechanical stress, posture, vibration, and temperature. The most important elements of tool design with regards to the human factors are size, shape, texture, ease of operation, shock absorption and weight.

Cumulative trauma disorders that may occur secondarily to poor hand tool design are trigger finger, synovitis, nerve compression, arterial compression, chronic strain, muscle strain, aggravation of arthritis, epicondylitis, vibration trauma, carpal tunnel syndrome and tendinitis.

II. Tool Handle Size and Shape

Tool handle size is an essential consideration in tool design to maximize grip strength, reduce stress and digital tendons, and avoid stress to the first collateral ligament. Considering male and female for a moment, the hand sizes are different. One size does not fit everyone. The smaller female hand with its smaller muscle mass will not tolerate inadequately levered tool handles or inadequate shock absorption. When a handle diameter is too large and the forces are applied at the fingers, the tendon forces can be two to three times greater than when the force is applied at the middle. Conversely, with a small handle, the fingers cannot effectively apply force because of the mechanically disadvantaged, shortened position of the finger flexors. Small handles can also result in muscle overcompensation and strain. This compromised position and its adverse effects are compounded when the wrist is flexed.

Therefore, when applying maximal crimping force, the wrist should be held in approximately Thirty degrees (30) of extension with small joints slightly flexed, thus allowing the extrinsic flexor muscles to work in a mechanically efficient position and in synergy with the intrinsic muscles. A partially stretched muscle will contract more forcefully than an unstretched muscle at the time of firing.

III. Handle Length

The length of the handle should be designed to minimize pressure to the median or ulnar nerve at the distal palm or wrist. It is recommended that handles be a least nine **cm** long to distribute forces evenly. Incorrect size of the handle can cause pressure to underlying tendons, sheaths, and nerves resulting in CTD's such as Trigger Finger, Tenosynovitis, Digital Neuritis, Joint Capsular injury, Carpal Tunnel Syndrome, and Guyon Canal Syndrome.

IV. Tool Contour

Handles should have a small contour to coincide with the curve of the transverse palmer arch and allow for even application of force. On the digital side, the handle should follow the natural palmer curve of the fingers as they flex toward the palm in order to distributed muscle loading evenly to the digits. This curve is contoured to accommodate the natural curve of the ulnar eminence. Short handles do not permit this accommodation and should be avoided or used only when light force is applied. Profiling of handles using digit separators is an

example of poorly designed contour from a biomechanical standpoint. Profiling restricts the range of the hand, impairing comfortable grasp of the tool. The prominence on the handle can cause joint capsule injury, trigger finger, neurovascular injury, or intrinsic strain. Because the neurovascular bundles are superficial on each side of the finger just lateral to the palmer fat pads, they lack protection and are susceptible to direct trauma. The edges of the finger separator on profiled handles can easily compress these structures.

V. Upper Extremity Posture during Tools Use

It is important to assume a correct posture when using tools to prevent shoulder strain, carpal tunnel syndrome, tenosynovitis, or epicondylitis. Tools should be designed so that use does not entail greater than twenty (20) degrees of abduction of the shoulder in the vertical position. Normally this shoulder position will not crate and excessive load. However, abduction greater than twenty (20) degrees increases the amount of shoulder strain.

A heavy hand tool markedly compounds the moment requirement of arm abduction. Research suggests that if shoulder abduction was approximately thirty (30) degrees, muscle fatigue occurred after a period of time three times longer than when abducted sixty (60) degrees, and six times longer than when abducted ninety (90) degrees. The height that is ideals for tall workers may require short workers to turn their wrists or abduct their shoulders.

Holding a tool with the wrist in prolonged ulnar deviation may cause carpal tunnel syndrome. When the wrist is maintained in ulnar deviation, creating ulnar drift of the tendons and tendon sheaths, there is a gradual increase in tenosynovitis, and carpal tunnel syndrome, owing to the altered position of the flexor tendons.

It is important to design the job and the handle so that the wrist is maintained in a neutral position, with the radius aligned with the second metacarpal by adjusting the posture and type of tool, and instruction the employee to keep the wrist straight, malalignment of the wrist is corrected. If the posture cannot be adapted because of the restrictions in design, the tool must be adapted. Job-site evaluations are sometimes needed to evaluate whether a right angle buffer or a pistol shaped sander is more appropriate for the job to be performed with the wrist in a neutral position. The orientation of the work space and location of work pieces relative to the worker's arm are decisive factors.

VI. Hand Tool Texture

Texture of the tool design is an important design consideration. Ergonomic research provided a basis in study to include texture as one of the most important elements of tool design. They found that a handle with a slippery finish or a dry hand requires added strength to retain the tool. If the texture is too coarse, skin irritation and reduce efficiency occur. A correctly textured tool allows for tool retention with minimal energy retention with minimal energy expenditure. Cross cut patterns and resilient rubber are good textures.

Tools must be designed to avoid transmission of shock or vibration to the hand

and upper extremities. Such transmission has been documented to contribute to vibration white finger syndrome, osseous injury, carpal tunnel syndrome, vasoconstriction, and Raynaud's syndrome. Tool vibration may adversely affect the digital arteries, causing permanent injury to the arterial walls.

It is necessary to select work gloves carefully for proper fit and to reduce the tendency for irritant to be embedded in the gloves. Wearing gloves tends to make gripping the tool more difficult. The worker wearing gloves grasps the tool more tightly, resulting in fatigue. Gloves that are too thick, separate the fingers and require oversight gripping. In some situations it may be better to design an energy-absorbing tool that does not require the worker to wear gloves.

The tools should be aligned with the axis of rotation of the wrist, and the tool center of gravity weighted at the middle of the palm in order to reduce rotary forces. The tools or the arm may be supported during use. The hand should be held in a relaxed neutral position, neither oversupinating nor overpronating.

VII. Tool Weight

Tool weight is as important as handle design. Light tools for light tasks is a good rule. Heavier tools can cause intrinsic strain, muscle spasm, tendinitis, and epicondylitis, but also possess adequate inertia to prevent transmission of excessive vibration. An overhead counterbalance, padded arm supports, or both should be considered to reduce the load moment on the shoulder. Tool balancers work by counterbalancing the weight of the tool with a long spring suspended over the work area. These are effective if the work area is limited in size to below the tool balance and the tool is used in one general orientation (vertical or horizontal) but not both.

RECOMMENDATIONS

Using ergonomic design and appropriate selection of hand tools for the prevention of cumulative trauma disorders is paramount. The principles and designs presented should help to reduce the biomechanical stresses on workers hand, arms, and shoulders. Proper tool design and use can improve productively and promote human wellness. In addition, the employer is able to reduce the costs of Workers' Compensation premiums by reducing injuries within the industry.

With the above mentioned criteria in mind, Dynabrade Inc. was chosen as the test company to provide tools. Twelve right angle die grinders and twelve buffers were purchased to accomplished the testing. The Dynabrade tools met the design aspects in regard to ergonomics and these tools are half the weight of the current tools. The tools are of a faster RPM because the less time an employee is mechanical cleaning, the less their chances of injury are. These tools are equipped with composite handles, and front port air exhausts, which will enable the worker to use gloves as an option. Eliminated is the constant icing on the buffers and the bulky handles associated with the Cleco grinders.

We are currently, in the testing stages with other tool manufactures for equipment that meets, competitive price standards, production standards and ergonomic standards. Dynabrade was tested first on the basis, that they provided tools immediately and were flexible with pricing. As other tools are tested and approved, results will be disseminated to the industry via panel meetings, to help reduce Workers Compensation costs.

The concept of wearing anti-vibration gloves while using vibratory hand tools needs further study. A larger sample, a control, a longer trial and additional objective data would improve future studies. Preventive measures need to be instituted in the workplace and therapies for these disorders instituted for the workers. Hand therapist and employers must study the work environment and improve it. All participants must be committed to research. Sound studies are dependent upon meticulous records, complete medical histories, worker production, and minimum absenteeism. The cost of the studies in time and dollars will be far out weighed by savings in production and decreased health care costs.

Appendix

SECTION A

CHART A-1

1994 - 1996 Age Related Injuries (32 - 44 years)

Wrist

Year	Nature of Injury	Years in Trade	Age
1994	Inflammation	3	40
1994	Inflammation	1	26
1995	Inflammation	2	26
1995	Inflammation	16	52
1995	Inflammation	4	29
1995	Sprain / Strain	4	35
1995	Sprain / Strain	16	39
1996	Sprain / Strain	3	44
1996	Sprain / Strain	3 Months	36

CHART A-2
1994 - 1996 Age Related Injuries (32 - 44 years)

Hand

Year	Nature of Injury	Years in Trade	Age
1994	Repeated Trauma	3	45
1994	Inflammation	4	36
1995	Inflammation	2	33
1995	Inflammation	3	44
1995	Inflammation	3	25
1995	Inflammation	3	35
1995	Inflammation	2	33
1995	Inflammation	3	36
1995	Inflammation	2	37
1995	Inflammation	3	39
1995	Inflammation	21	63
1996	Inflammation	1	33
1996	Inflammation	6	35

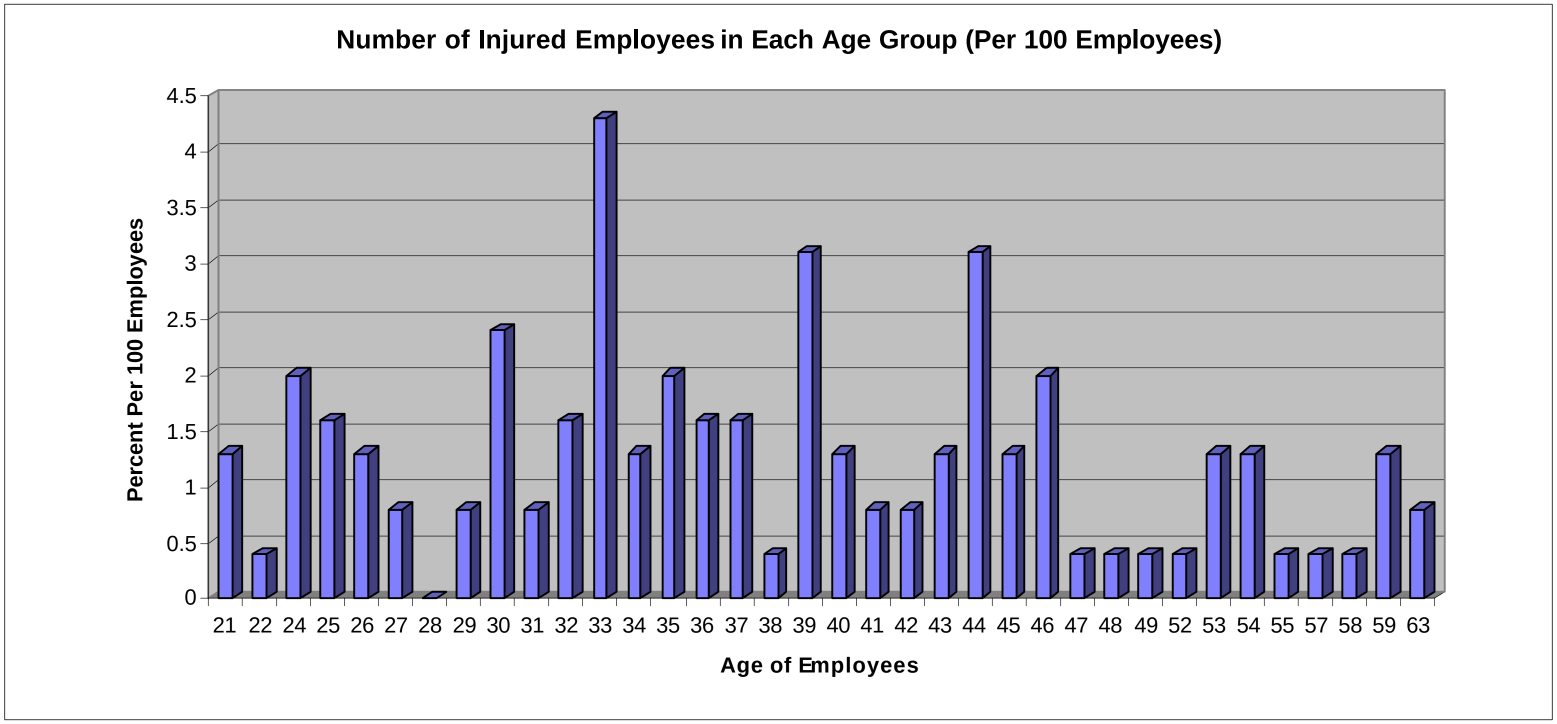
CHART A-3

1994 - 1996 Age Related Injuries (32-44years)

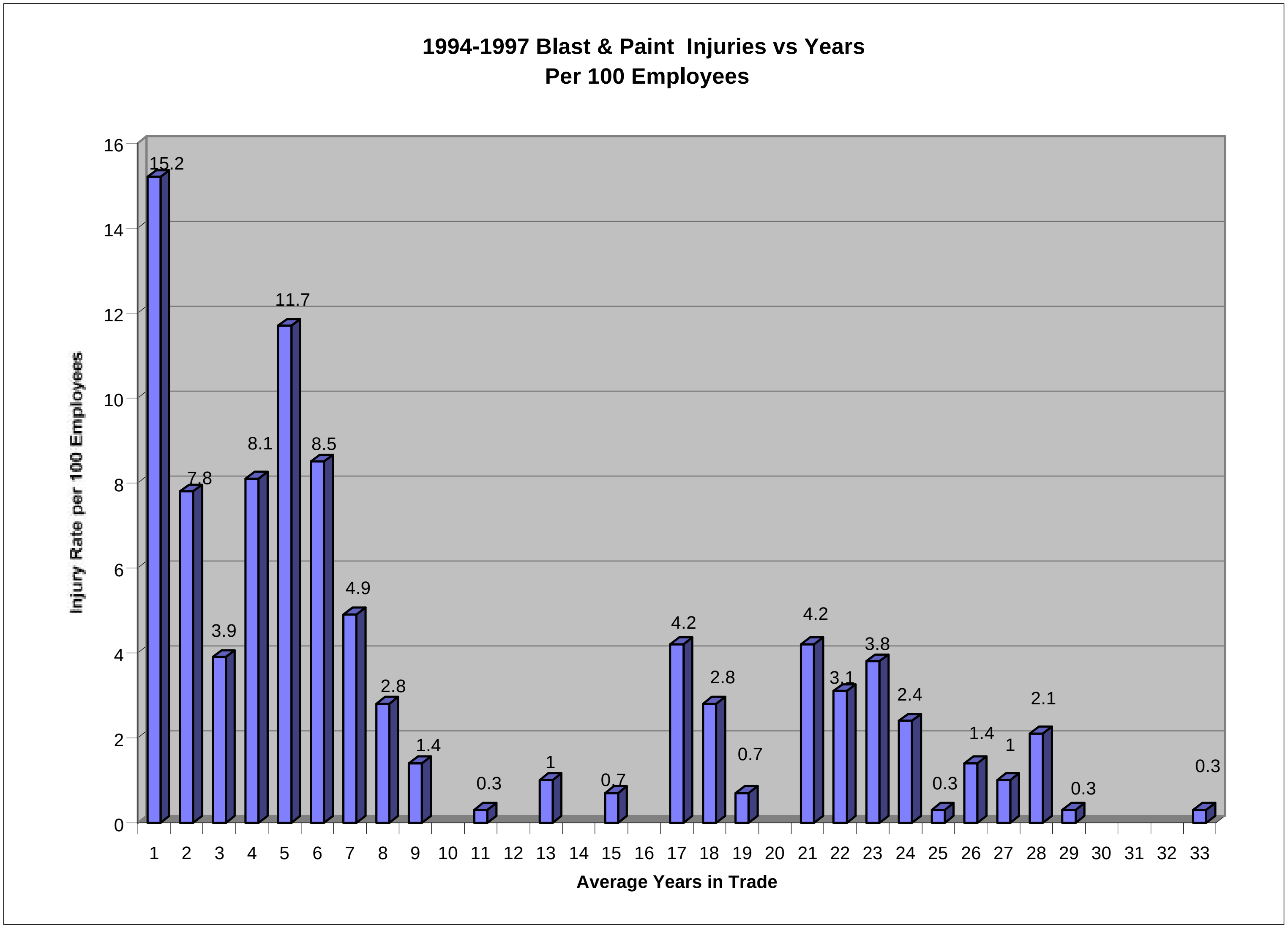
Fingers

Year	Nature of Injury	Years in Trade	Age
1994	Sprain / Strain	4	46
1994	Sprain / Strain	15	44
1994	Fracture	20	46
1994	Strain / Sprain	1	24
1994	Strain / Sprain	1	27
1995	Strain / Sprain	14	40
1996	Fracture	3	33

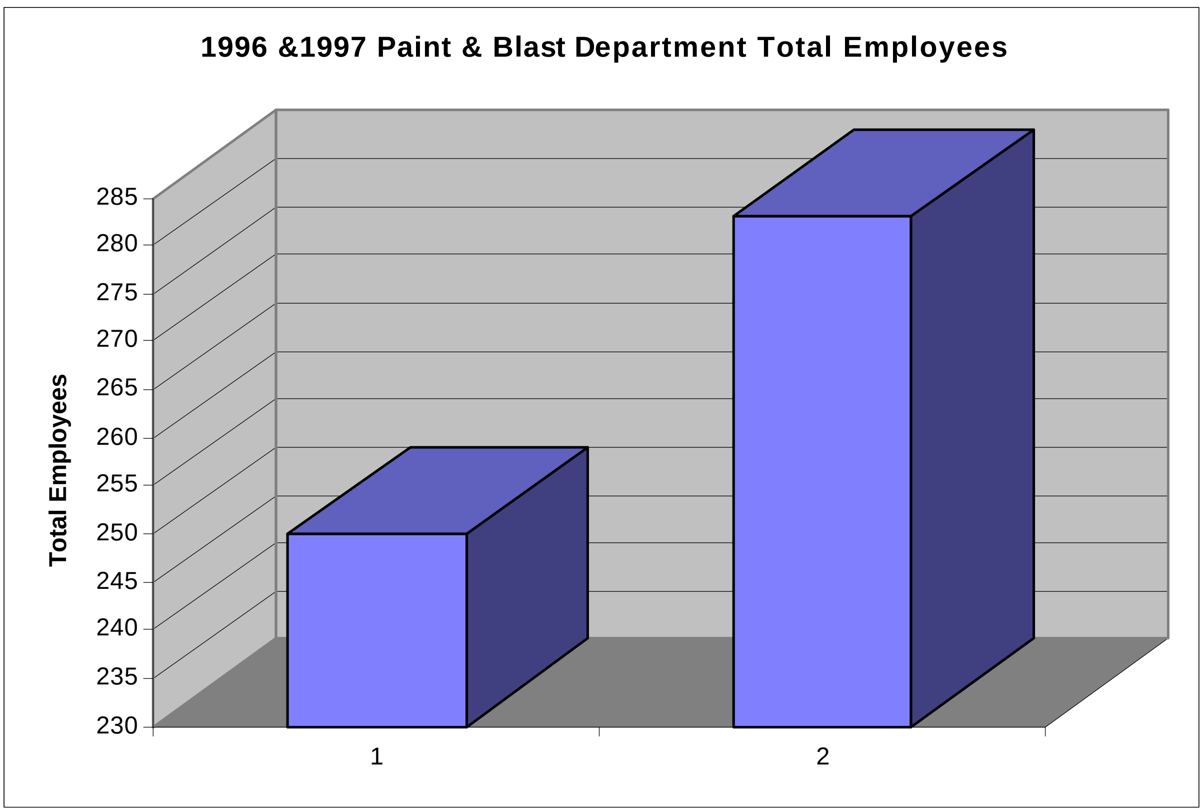
SECTION B

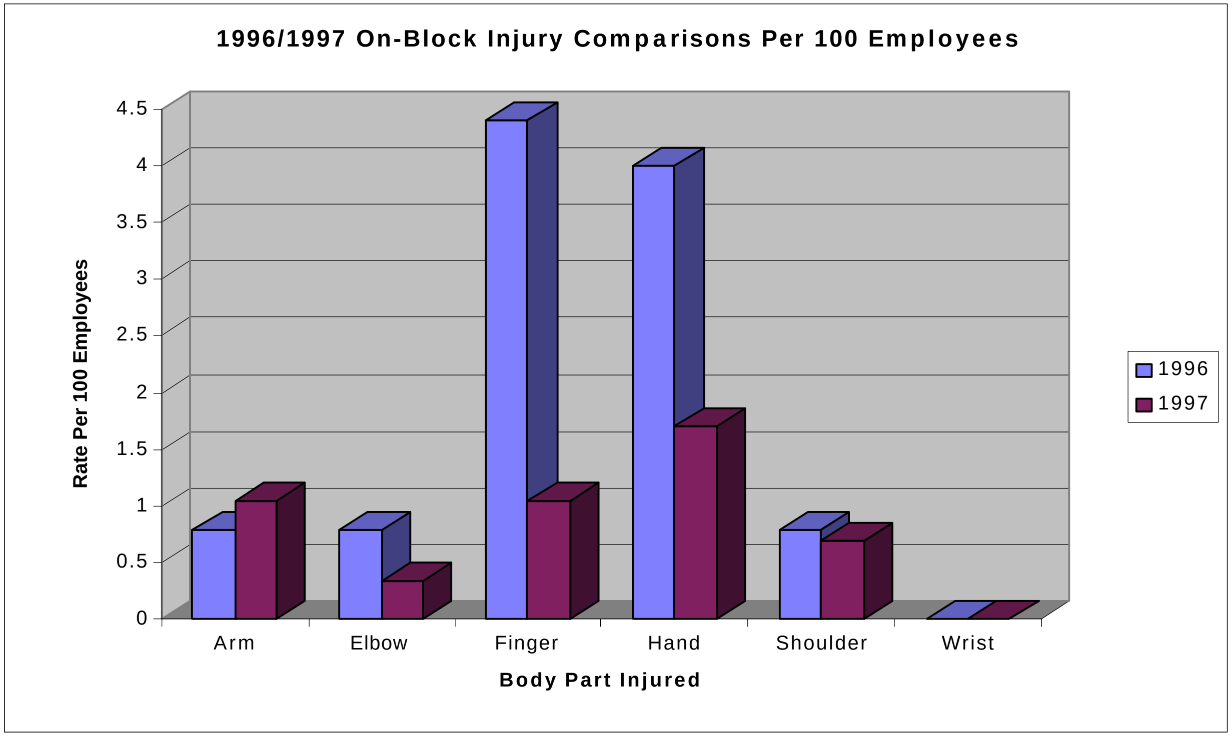

Number of Injured Employees in Each Age Group (Per 100 Employees)
Percent Per 100 Employees
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
21 22 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 52 53 54 55 57 58 59 63
Age of Employees

SECTION C

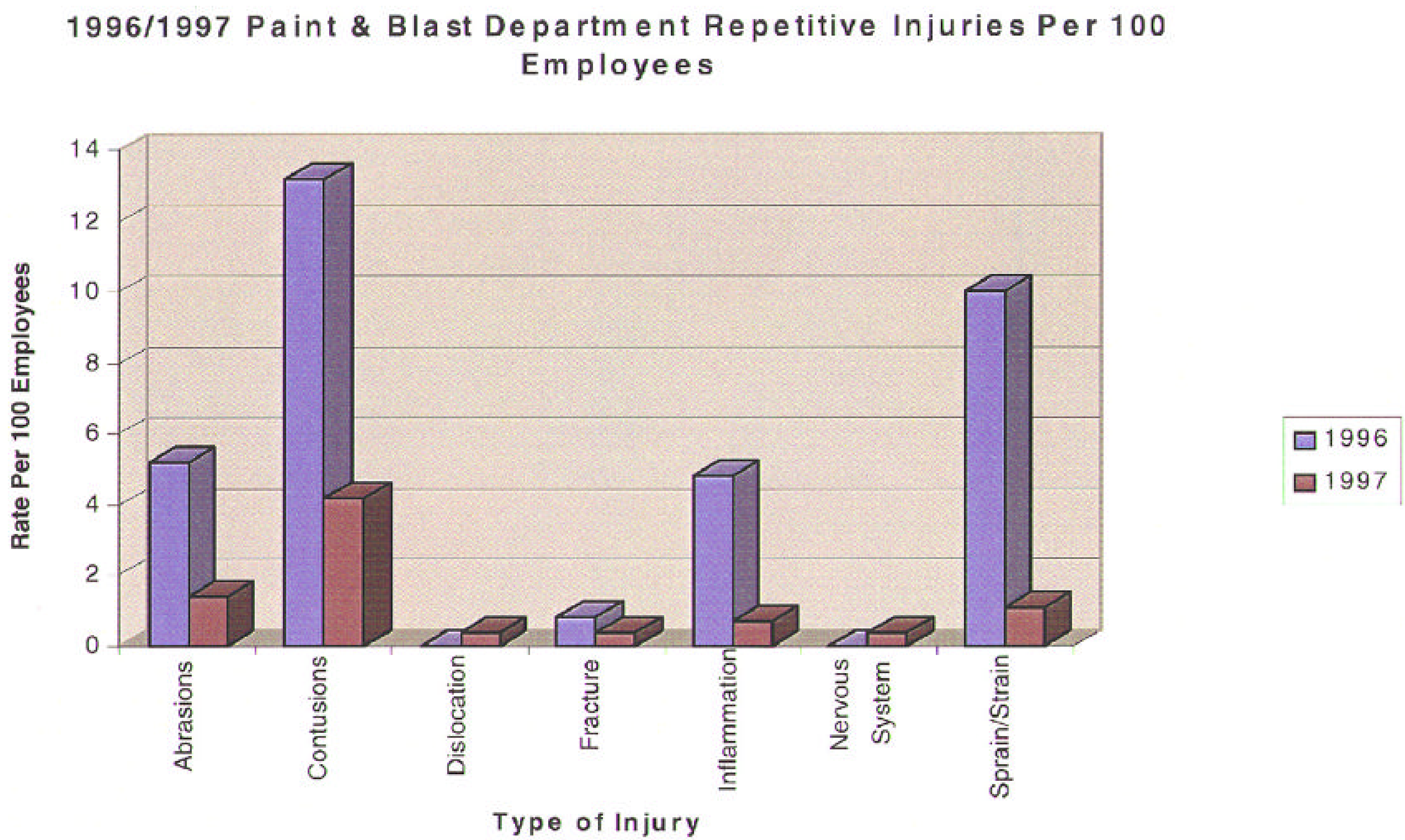

1994-1997 Blast & Paint Injuries vs Years
Per 100 Employees
Injury Rate per 100 Employees
Average Years in Trade
0
2
4
6
8
10
12
14
16
15.2
7.8
3.9
8.1
11.7
8.5
4.9
2.8
1.4
0.3
1
0.7
4.2
2.8
0.7
4.2
3.1
3.8
2.4
0.3
1.4
1
2.1
0.3
0.3
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33

SECTION D

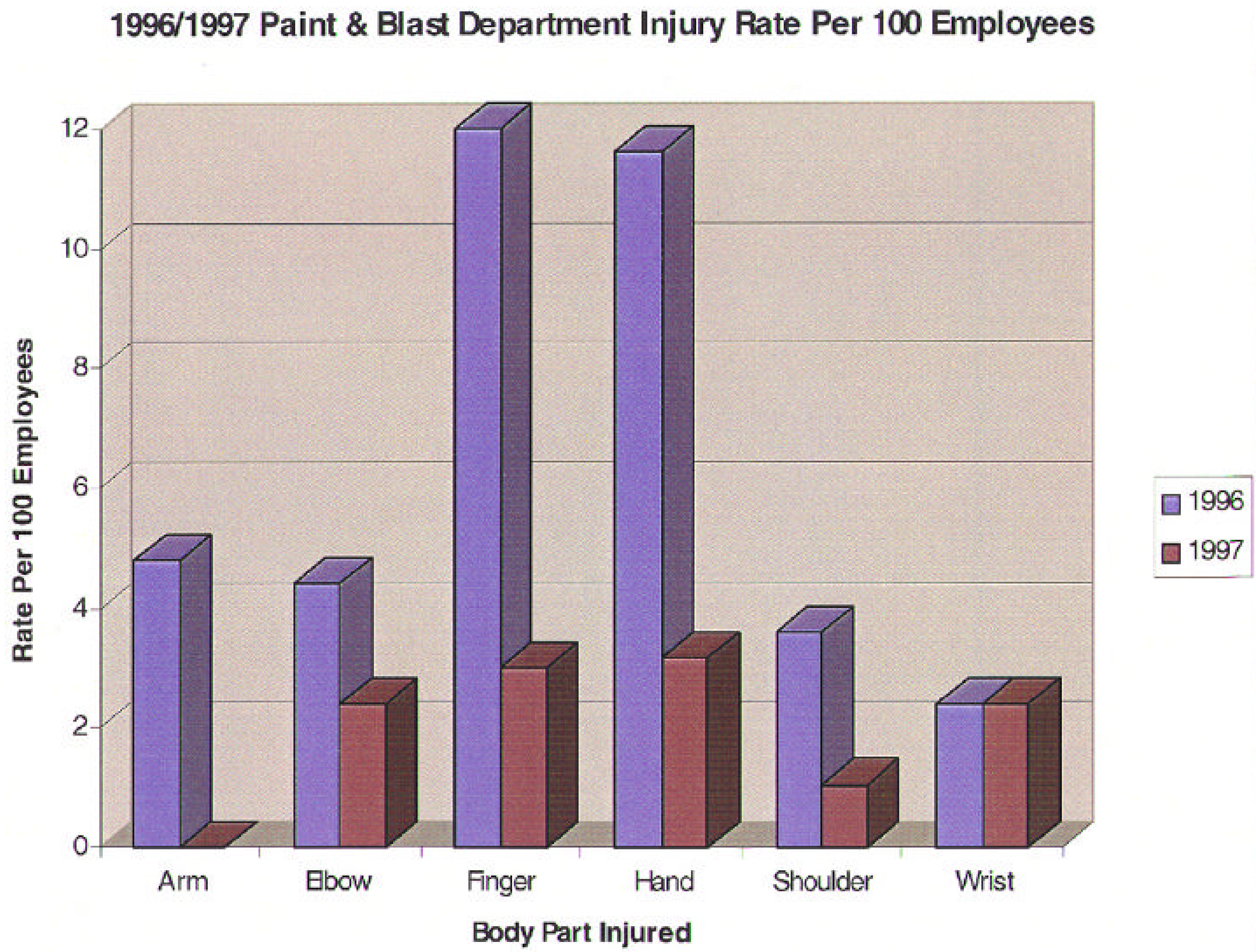

1996 &1997 Paint & Blast Department Total Employees
Total Employees
285
280
275
270
265
260
255
250
245
240
235
230
1
2



1996/1997 On-Block Injury Comparisons Per 100 Employees
Rate Per 100 Employees
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
Arm
Elbow
Finger
Hand
Shoulder
Wrist
Body Part Injured
1996
1997



1996/1997 Paint & Blast Department Repetitive Injuries Per 100 Employees
Rate Per 100 Employees
14
12
10
8
6
4
2
0
Abrasions
Contusions
Dislocation
Fracture
Inflammation
Nervous System
Sprain/Strain
Type of Injury
1996
1997


1996/1997 Paint & Blast Department Injury Rate Per 100 Employees
12
10
8
6
4
2
0
Rate Per 100 Employees
Arm
Elbow
Finger
Hand
Shoulder
Wrist
Body Part Injured
1996
1997

SECTION E

Chart E-1

1995 AND 1996 PAINT AND BLAST DEPARTMENT INJURY ANALYSIS

SUMMARY:

1. There were 46 lost time injuries during this time period. Of this number, 29 were injuries to soft tissues of the hands, arms and shoulders; and 17 due to traumas.

   a. Eight of the 46 were sprains, strains, or spasms.

   b. 21 of the 46 were inflammation & tendinitis.

2. Hands (12) were the most commonly injured body part, followed by arms (5) and shoulders (4).

3. Work Activities most affected for the soft tissue injuries:

   10/29 Grinding
   10/29 Material Handling
   5/29 Manual activities not involving mechanical tools, such as solvent wiping etc.
   3/29 Moving about, i.e.. walking, climbing, descend, etc.
   1/29 Grit Blasting

4. 16 Repetitive motions and 11 over exertions total = 27 of the 29 soft tissue injuries.

CONCLUSION:

1. Hands, arms, and shoulder injuries are a major source of lost time injuries in the Paint and Blast Department.

2. Grinding and material handling contribute equally with manual activities second.

3. Repetitive motion is the major cause of injuries with overexertion second.

SECTION F

Stretching Exercises (drawings unavailable)

1 Separate and straighten your fingers until tension of a stretch is felt. Hold for 10 seconds. Relax, then bend your fingers at the knuckles and hold for 10 seconds. Repeat stretch of straightened fingers once more.

2 This stretch may cause people around you to think you are very strange, indeed, but you often find a lot of tension in your face from eye strain. Raise your eyebrows and open your eyes as wide as possible. At the same time, open your mouth to stretch the muscles around your nose and chin and stick your tongue out. Hold this stretch for 5-10 seconds. Caution: if you have clicking or popping noises when opening mouth, check with your dentist before doing this stretch.

3 Shoulder Shrug: Raise the top of your shoulders toward your ears until you feel slight tension in your neck and shoulders. Hold this feeling of tension for 3-5 seconds, then relax your shoulders downward into their normal position. Do this 2-3 times. Good to use at the first signs of tightness or tension in the shoulder and neck area.

4 With fingers interlaced behind head, keep elbows straight out to side with upper body in a good aligned position. Now pull your shoulder blades toward each other to create a feeling of tension through upper back and shoulder blades. Hold this feeling of mild tension for 8-10 seconds, then relax. Do several times. This is good to do when shoulders and upper back are tense or tight.

5 Start with head in a comfortable, aligned position. Slowly tilt head to left side to stretch muscles on side of neck. Hold stretch for 10-20 seconds. Feel a good, even stretch. Do not over stretch. Then tilt head to right side and stretch. Do 2-3 times to each side.

6 From a stable, aligned sitting position, turn your chin toward your left shoulder to create a stretch on the right side of your neck. Hold right stretch tensions for 10-20 seconds. Do each side twice.

7 Gently tilt your head forward to stretch the back of the neck. Hold for 5-10 seconds. Repeat 3-5 times. Hold only tensions that feel good. Do not stretch to the point of pain.

8 Repeat stretch # 3

9 Hold your left arm just above the elbow with the right hand. Now gently pull elbow toward opposite shoulder as you look over your left shoulder. Hold stretch for 15-30 seconds. Do both sides.

10 Interlace fingers, then straighten arms out in front of you. The palms should be facing away from you as you do this stretch. Feel stretch in arms and through the upper part of the back (shoulder blades). Hold stretch for 20-30 seconds. Do at least two times.

11 Interlace fingers then turn palms upwards above our head as you straighten your arms. Think of elongating your arms as you feel a stretch through arms and upper sides of rib cage. Hold for 10-20 seconds. Hold only stretches that feel releasing. Do three times.

12 Hold left elbow with right hand, then gently pull elbow behind head until an easy tension stretch is felt in shoulder or back of upper arm (triceps). Hold easy stretch for 20 seconds. Do not over stretch. Do both sides.

13 Hold onto your lower leg just below the knee. Gently pull bent leg toward your chest. To isolate a stretch in the side of your upper leg, use the right arm to pull bend leg across and toward the opposite shoulder. Hold for 30 seconds at easy stretch tension. Do both sides.

14 A stretch for the side of hip, lower and middle of back. Sit with left leg bent over right leg, then rest elbow or forearm of right arm on the outside of the upper thigh of the left leg. Now apply some controlled, steady pressure toward the right with the elbow or forearm. As you do this, look over your left shoulder to get the stretch feeling. Do both sides. Hold for 15 seconds.

15 The next stretch is done with fingers interlaced behind your back. Slowly turn your elbows inward while straightening your arms. An excellent stretch for shoulders and arms. This is good to do when you find yourself slumping forward from your shoulders. This stretch can be done at any time. Hold for 5-15 seconds. Do twice.

16 To stretch your calf, stand a little ways from a solid support and lean on it with your forearms, your head resting on your hands. Bend one leg and place your foot on the floor in front of you, leaving the other leg straight behind you. Slowly move your hips forward until you feel a stretch in the calf of your straight leg. Be sure to keep the heel of the foot of the straight leg on the floor and your toes pointed straight ahead. Hold an easy stretch for 30 seconds. Do not bounce. Stretch both legs.

SECTION G

Vendor Product Evaluation

Product Name:
Evaluator:
User(s):

Date:
Where Evaluated:
Length of Evaluation:

Category	Description	Y	N	Comments
Convenience	Is the product easy to use?			
Safety	Is the product safe to use?			
Economy	Is the product too expensive to use?			
Simplicity	Is the product unnecessarily complicated?			
Comfort	Is the product uncomfortable to use?			
Durability	Is the product likely to break or malfunction?			
Compatibility	Does the product work with existing equipment or systems?			
Maintainability	Are replacement parts readily available?			
Competition	Does the new product have any advantages over the one being used now?			
Implementation	What changes will the product bring?			
People	What effect will the product have on people?			

CHART G-2

DYNABRADE
BUFFER/GRINDER
STATUS SHEET

DATE ____________

NUMBER OF BUFFER	TIME OF USAGE	NUMBER ON GRINDER	TIME OF USAGE	SHIFT	BADGE #

SECTION H

NASSCO
Safety & Prevention Program

Paint & Blast
Process Improvement Team

Therapy Specialists met with your team to discuss the PIT objectives in reducing workplace injury and increasing safety awareness. Safety and prevention, through the combined efforts of employer and rehabilitation professionals, is a concept that many corporations are embracing nationwide.

Therapy Specialists offers the expertise of a medically-based program that will provide the practical experience of clinically working with the types of injuries you sustain and their specific job classifications, and applying that knowledge to a prevention program. We hope to create a partnership with NASSCO by supporting your program with the resources that will make a safe and healthy workplace!

PROGRAM REVIEW

1. PIT actions to date
   - Interaction with glove/tool vendor
   - Safety clips/handouts to promote awareness
   - PIT composition: industrial hygienist/safety/supervisor/management roles
   - Painter trade class injury record (1995 & 1996)

2. Paint & Blast Department Tour
   - View worksite/job tasks
   - Handle tools/gloves utilized in daily activities
   - Brief interview of supervisors

3. Role of Therapist in PIT process
   - Introduction of physical and hand therapist expertise
   - Discuss current treatment program/protocols for Nassco job classes
   - Discuss return-to-work/worksite conditioning concepts

RECOMMENDATIONS

Physical Testing

Your injury data revealed that the individuals sustaining injuries in the painter trade class are, on average, approximately 40 years in age. You also shared that they are typically on the job from one to five years. This has prompted Nassco's HR Department to look at current hiring criteria. It should also serve as an indicator that potential new hires need to be screened to assure that they are physically capable in meeting the demands of their job class. Our recommendation is physical testing be implemented to capture baseline data on specific trade classes and screen potential new hires.

Physical testing could be the most important criteria in impacting the low bac and cumulative trauma injuries. Matching an employee's ability to the essential functions of their job will allow you to eliminate the potential of hiring someone or placing an injured worker back into a job class that is inappropriate for them.

Research into industry methods and trends in injury prevention indicate that implementing systems to match an employee to the physical requirements of a job can be the most effective way to prevent an injury from occurring. As a licensed site for the WorkSTEPS program, Therapy Specialists offers a medically reliable and legally defensible testing program that is ADA and EEOC compliant.

Pre-Employment/Post-Offer Physical Testing

- Four levels of testing available
- Testing is matched to your specific job descriptions

Functional Capacity Evaluations

- Physically measures an injured's ability to return to their job class

Fitness-for-Duty Testing

- Administered to employees who demonstrate difficulty performing essential functions of the job.

Injury Prevention (Generalized or job class specific)
Training for supervisors, work groups, or teams.

Education/Awareness Programs

Topics: Body Mechanics (musculoskeletal review)
Back to basics (back injury prevention)
Postural Stability (cumulative trauma prevention)

Health & Fitness Programs

Topics: Wellness (smoking cessation/healthy diet/exercise/etc)
Stretching & Pacing Throughout the Work Day

Consultation
Task Breaks & Task Rotation
Tool/Equipment Modification & Selection
Safety Incentive Program Development
Injury Prevention Data Collection & Review
Ergonomic Worksite Evaluations
Job Analysis

Onsite Services

Transitioning an employee from injury to work expeditiously, can reduce the psychological implications and significant costs associated with disability. These programs coordinate the efforts of employee, supervisor and treating physician, to attain the most effective transition from all levels of injury. The clinician works with the employee in the actual workplace, allowing the clinician to effectively evaluate the employee's limitations and progress them to full recovery.

Injury Treatment
Work Hardening/conditioning on the job
Modified Duty & Light Duty Transitioning

SECTION I

NORTON COMPANY

Kimberly Watson
2355 San Ramon Valley Blvd.
San Ramon, CA 94583-1607
Phone: 619-930-9464
Fax: 619-930-9465
Voice-Mail: 800-826-0455 x3572

Attn-. Fred Hogan
Tony Robinson
Judie Blakey
Craig Williams

Ref Norton Test on AVOS

Dear Team:

I would like to begin by offering my sincere appreciation for allowing me the opportunity to test our new product, AVOS, at your facility. Recently NASSCO has voiced some concerns about safety and grinding techniques in the paint and blast department. As a result, I have made some recommendations to help address your concerns. The following is what we have found:

Test 1 - AO-243
Procedure:
1. Grind all weld seams with AVOS F226 36 grit 4-1/2 inch. Create appropriate profile for quality control.
2. Spot check weld seams for any additional cleaning. Use AVOS Bear-Tex coarse grit 4-1/2 inch to clean any missed grooves or divots.

Number of grinders used:
2
Time:
Test began at 8:00 am
Clean up before paint began at 10-40
Total grind for weld seams- I hr 50 min.
Material Used: 6 grit
4 AVOS F226 3
1 AVOS Bear-Tex Coarse
Amount of material to be ground:
2117 linear inches of weld seam

<u>Test 2 - AO-244</u>

Procedure:

1. Clean weld seams with 4-1/2 inch wirewheel
2. Clean weld seams with 7 inch 3M clean & strip pad
3. Create profile on weld seams with 7 inch fiber disc 36 grit.

Number of Grinders Used:
3
Time:
Test began at 7-30 A.M.
Clean up for paint began at 10 - 5 0 A.M.
Material Used.
3 wire wheels (simultaneously)
3 Clean & strip pads (simultaneously)
3 Fiber discs 36 grit (Totally consumed)
Amount of material to be ground
1578 linear inches of weld seam

<u>Conclusions</u>:
Although the total preparation time & material cost was less with the Norton process as is evident from the data, I would like to point out some key factors separate from labor and material costs.

First, the weight of wire wheel brushes is sigruificantly more than that of the AVOS product. This makes if more difficult for the operator to control the tool and creates additional strain on the wrist muscles. In addition, small pieces of wire release from the wheel while grinding at a rate of 13,000 RPM and can embed in clothing and any exposed skin. This is not a problem with the AVOS products. Quality control voiced concerns over the profile left by a wire wheel. It is not acceptable. However,
the profile is acceptable with AVOS. Wire wheel brushes can not create a distinct edge along side the weld seam and for that matter neither can the fiber discs used at NASSCO. On the other hand, the AVOS product has no problems grinding an edge. This eliminates any need for using a needle gun along the weld seams which is currently required.

Secondly, the back up pad for the AVOS product is much lighter than the seven inch rubber back up pad currently used in the paint and blast department. The lighter product is easier to use and reduces the amount of muscle fatigue experienced by operators. Furthermore, AVOS is designed to be used at a 5-10 degree angle versus NA ;SQ14ber discs which require a 30-45 degree angle. Again, we are reducing the possibility of injury and fatigue. When grinding overhead the spark stream is sweeping away from the operator where as traditional fiber discs sparks fall on the operator's face. Most importantly, the operator can see through the AVOS product and therefore hold the grinder at a much more comfortable angle.

Finally, as seen in the data, the AVOS product did more work on more material than the NASSCO fiber disc and lasted longer. We were able to eliminate the use of a wire wheel and clean and strip pad. The profile achieved with the AVOS product was more acceptable than that done in the traditional NASSCO process. The AVOS product alone, out performed the current fiber. disc. Therefore, even if

the paint & blast department where to maintain the current process, Norton can still provide a cost savings using AVOS fiber discs versus NASSCO fiber disc.

I look forward to continuing to help NASSCO improve on its current processes. We are scheduled to present a safety seminar on the 21st and 22nd of May. I hope you find that Norton is committed to addressing all of NASSCO's needs.

Sincerely,

7

Kimberly Watson
Sales Representative
Norton Co.

cc- Cris Ferregur

SECTION J

CHART J-1

1997 Blast and Paint Department Actual Cost Analysis

Injury Type	**Number of Injuries**	**Average Cost**	**Total**
Arm	3	$24,246.33	**$72,739.00**
Elbow	5	$10,514.00	**$52,570.00**
Finger	9	$5,217.55	**$46,958.00**
Hand	4	$54,964.50	**$219,858.00**
Shoulder	6	$23,877.50	**$143,265.00**
Wrist	3	$5,269.00	**$15,807.00**
TOTAL			**$551,197.00**

CHART J-2

1997 Workers Compensation Cost Comparison to 1996

Body Part	1996 Injuries	1997 Injuries	1996 Rate	1997 Rate	Diff (-) '96 Rate	'96 Per Injury Total	Total Savings
Arm	13	3	14.7	3.4	11.3	$21,870.72	**$243,870.72**
Elbow	11	5	12.4	5.6	6.8	$16,632.99	**$113,104.33**
Finger	30	9	33.9	10.1	23.8	$6,397.77	**$152,266.93**
Hand	29	4	32.8	4.5	28.3	$20,945.10	**$592,746.33**
Shoulder	9	6	10.1	6.8	3.3	$14,298.67	**$47,185.61**
Wrist	7	3	7.9	3.4	4.5	$12,055.08	**$54,247.86**
TOTAL							**$1,203,421.78**

Note: 1. Rates obtained by 283/250=1.132 x Each Year Number of Injuries
2. Based on 1997 & 1996 Head Counts
3. 1996 Rates Restated based on Frequency Rates

CHART J-3

PAINT DEPARTMENT CLAIMS COSTS BY YEAR FOR HAND, WRIST AND ELBOW			
Year	1994	1995	1996
Number of Claims	12	15	12
Total Est. Cost	$239,893	$272,797	$201,169
Cost per Claim	$19,991	$18,186	$16,764

CHART J-4

TOTAL ACTUAL COST INCURRED FROM JULY 1995 TO JUNE 1996 (SHOULDER AND FINGER NOT INCLUDED)	
Painter Helper	$4,493
Abrasive Blaster	$227,488
Painter	$942,260
TOTAL	**$1,174,241**

CHART J-5

1996 BLAST AND PAINT DEPARTMENT COST ANALYSIS			
INJURY TYPE	**NO. OF INJURIES**	**AVERAGE COST**	**TOTAL**
Arm	13	$21,581.48	$280,559.24
Elbow	11	$16,632.90	$182,962.89
Finger	30	$6,397.77	$191,933.10
Hand	29	$20,945.10	$607,407.90
Shoulder	9	$14,298.67	$128,688.03
Wrist	7	$12,056.51	$84,395.57
TOTAL			**$1,475,946.73**

SECTION K

CHART K-1

Injury Rate of Body Parts injured in the Blast and Paint Department (Per 100 Employees)

YEAR	1996	1997
Blast & Paint Employees	**255**	**287**
Number of Injuries	**96**	**35**
Injury Rate/ Per 100	**38%**	**12%**
Rate Reduction		**68%**

CHART K-2

Repetitive Motion Injury Rates

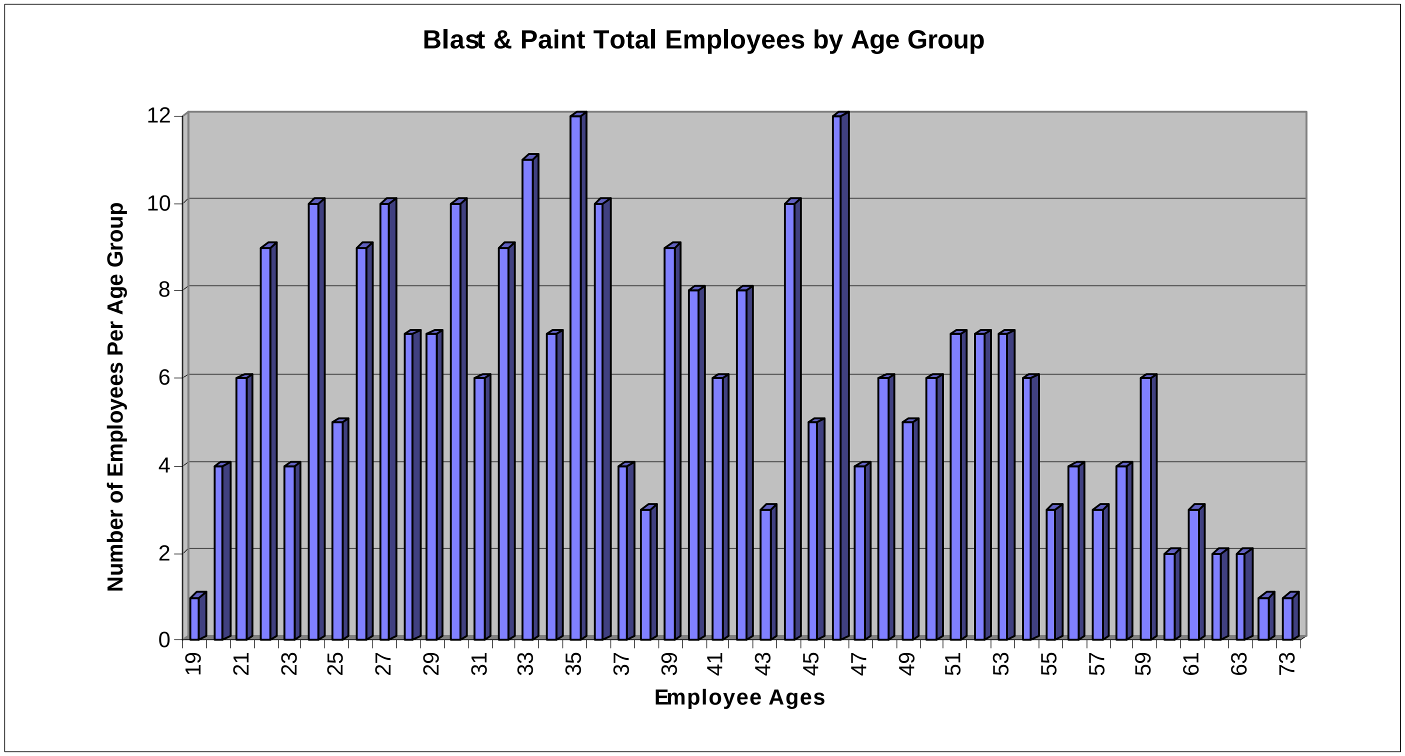
Number of Injuries	**37**	**6**
Injury Rate/ Per 100	15%	2%
Rate Reduction		**87%**

CHART K-3

On-Block Injury Rate

Number of Injuries	**27**	**14**
Injury Rate / Per 100	**11%**	**5%**
Rate Reduction		**55%**

Section L


Blast & Paint Total Employees by Age Group
Number of Employees Per Age Group
Employee Ages
0
2
4
6
8
10
12
19
21
23
25
27
29
31
33
35
37
39
41
43
45
47
49
51
53
55
57
59
61
63
73

DELIVERABLE C

BLAST AND PAINT DEPARTMENT EYE INJURIES

BACKGROUND

During 1996 and 1997, the Blast and Paint Department incurred 118 eye injuries, 99 first aid injuries and 19 recordable, 15 in 1996 and 4 in 1997. The types of eye injuries were abrasions, infections, irritations, rust rings, embedded foreign bodies and loose foreign bodies. Eye injuries have always been difficult to prevent in Blast and Paint due to the nature of work which includes painting, solvent washing, grinding, sanding, abrasive blasting and mechanical cleaning.

Due to the decrease in abrasive blasting, it was now standard operating procedure to mechanical clean and solvent wipe fabricated units in the on-block area. With the increase in mechanical cleaning and solvent wiping, dirt, sand and other debris embedded in the workers clothing became a source of problems. When a worker is mechanical cleaning in the overhead areas of an fabricated unit, for instance, dust particles fall downward and collect on clothing, safety glasses, respiratory protection, hands and face. The dust can only be removed by air blowdown hoses, vacuum hoses and by the workers dusting themselves after completion of work tasks. This procedure tends to be a problem because of, dust particles remaining in the atmosphere or settled dust on eye or respiratory equipment. When the employee removes Personal Protective Equipment from their face, loosened particles fall into the eyes causing a variety of first aid injuries, such as loose foreign body or embedded foreign body injuries.

The process of mechanical cleaning in an enclosed area, such as inside a closed compartment or isolated compartment outside, poses a threat to eye safety due to particles flying in the atmosphere or the air discharged from power tools dislodging loose particles from clothing and machinery. The employees are equipped with safety goggles and face shields to prevent eye injuries, but this process has not been totally effective in reducing eye injuries. Part of the problem has been the equipment, but much of the problem can be attributed to the employee.

Paint and Blast employees from several areas such as On board, On block and Paint pit areas were observed for several weeks. The observations were done to note tendencies, problems with existing Personal Protective Equipment, possible non-compliance and opportunities to change or modify current eye protection equipment. Employees were observed on several occasions, either not wearing eye protection, blowing air across their clothing to remove sanding/grinding debris or not taking the extra effort to thoroughly remove loose debris from personal protective equipment before removal. During these observations, some other issues arose such as current safety glasses fitting loosely, safety hazards with air feed respirator lines and injuries resulting from removing safety glasses and goggles from the employee's face.

PARTICIPANTS

This project is concurrent with the Blast and Paint department goal of reducing hand, wrist and arm injuries within stages of construction Three and Five due to mechanical cleaning.

NAME	JOB TITLE	DEPARTMENT
**Andre Dorais	Facilitator	Training
**Indy Parra	Production Supervisor	Paint & Blast
**Bobby Flores	Production Supervisor	Paint & Blast
Jim Ferguson	Industrial Hygienist	Safety
**Arthur Green	Production Supervisor	Paint & Blast
Tony Robinson	Corrosion Control Specialist	Paint & Blast
Mario Cosio	Ass't Superintendent	Paint & Blast
Judie Blakey	Superintendent	Paint & Blast
Jim Paulson	Manager Safety	Safety
Craig Williams	Staff Engineer	Paint & Blast
Manuel Faria	Painter	Paint & Blast
Jorge Hernandez	Working Foreman	Paint & Blast
**Freddie Hogan	Project Engineer	Human Resources

Note: ** Denotes current Team Members.

EYE PROTECTION

More than 90,000 eye injuries occur each year in the United States resulting in lost production time, medical expenses and workers compensation. No dollar figure can adequately reflect the personal toll these accidents take on the injured workers. Many of these could have been prevented with proper protective eyewear.

The Occupational Safety and Health Administration and the 25 states and territories operating their own job safety and health programs are helping to reduce eye injuries nationwide. Cal/OSHA requires that protective eyewear be worn wherever there is the potential for injury from flying particles, hazardous substances, or dangerous light. The eyewear must meet the standards put forth by the American National Standards Institute. Safety wear that meets this standard has "Z87.1 imprinted on the frame or lens.

1. Types of Protective Eyewear

a. Safety Glasses: Safety glasses with side shields are designed to protect the eye from particles, projections, and , to a certain degree, hazardous chemicals. (Safety glasses must have side shields to meet the ANSI standard. Removing the shields voids the ANSI approval.) The lenses are impact resistant, and the frames are much stronger than those found on fashion eyewear.

   Most safety glass lenses are made of polycarbonate, although some are made of glass. Glass lenses are more resistant to chemicals and cleaning solvents and may be a better choice in situations where the glasses will require frequent cleaning. Safety glasses are available with either plano (non-corrective) or prescription lenses.

b. Goggles: Goggles provide more protection than safety glasses and should be worn wherever there is a potential for hazardous liquids to splash. In general they provide much better protection from smaller particles and liquids because they seal against the face. Also, they can be worn over normal prescription lenses if needed.

c. Face Shields: Face shields protect both eyes and face when working with strongly corrosive chemicals that pose a splash hazard. Because face shields do not seal against the face, goggles should be worn under a face shield when handling strong corrosives.

d. Welding/Chipping Goggles: Welding goggles are designed to protect your eyes from both hazardous light and hot particles. Among its other hazards, welding can generate infrared (IR) light. IR- safe lenses have special IR-absorbing dyes molded into them. Their degree of protection is rated on a "shade" scale. The higher the shade number, the higher the protection from IR. Be sure the glasses, goggles, or shields you pick have a high enough shade factor for your kind of work. Tint alone doesn't guarantee protection. Chipping goggles are untinted and should be used where flying chips or flakes of material are a problem.

2. Contributors to Eye Injury at Work

a. Not wearing eye protection. The Bureau of Labor Statistics reports that nearly three out of every five workers injured were not wearing eye protection at the time of injury.

b. Wearing the wrong kind of eye protection. Usually injured workers were wearing some form of eye protection when the accident occurred. These workers were most likely to be wearing protective eyeglasses with no side shields, though injuries among employees wearing full-cup or flat-fold shields occurred, as well.

3. Causes of Eye Injuries

a. Flying particles. BLS found that almost 70% of the accidents studies resulted from flying or falling objects or sparks striking the eye. Injured workers estimated that nearly three-fifths of the objects were smaller than a pin head. Most of the particles were said to be traveling faster than a hand-thrown object when the accident occurred.

b. Contact with chemicals caused one-fifth of the injuries. Other accidents were caused by objects swinging from a fixed or attached position, like tree limbs, ropes, chains, or tools which were pulled into the eye while the worker was using them.

4. How Can Eye Injuries Be Prevented?

a. Always wear effective eye protection. To be effective, the eyewear must be of the appropriate type for the hazard encountered and properly fitted. When an employee is injured wearing eye protection, it is because objects have gone around or under the protector. Eye protective devices should allow for air to circulate between the eye and the lens.

b. Use goggle as much as possible. Goggles generally provide better eye protection with face shield than safety glasses.

c. Better training and education. Workers injured while not wearing protective eyewear most often said they believed it was not required by the situation. Make sure all employees have proper information on where and what kind of eyewear should be used.

d. Maintenance. Eye protection devices must be properly maintained. Scratched and dirty devices reduce vision, cause glare and may contribute to accidents.

CONTACT LENSES IN THE WORK ENVIRONMENT

The use of contact lenses in the chemical/dust environment complicates eye safety. Contact lenses have the potential to trap dusts or chemicals (gases or vapors) behind the lens and cause irritation, excessive eye watering and /or damage to the cornea; also, a chemical splash may be relatively more injurious when contact lenses are worn because the removal of the lenses may be delayed, restricting first aid and prolonging the exposure time. There are some who feel contact lenses give added eye protection and help to minimize injury; the scientific information on this issue continues to be sketchy and is controversial.

It is generally accepted that contact lenses are not, in themselves protective devices; it is strongly recommended that contact lenses not be worn where:

- gases, vapors or other materials are present which, when absorbed by contact lenses, may harm the eyes;

- dust or other materials are present which may harm the eyes or cause distraction which may expose the worker to other injury;

- there is significant potential for chemical splashing to the eyes from injurious chemicals such as acids and alkalis.

RESULTS

Paint and Blast personnel were observed for several weeks to determine the causes of eye injuries in the production areas. In addition to the sheer volume of mechanical cleaning, an additional safety hazard was noted. This safety hazard was the abundance of airlines to power tools and air supplied respirators. During the workday, employees were observed performing work area cleanup, personal cleanup, and restowage of equipment.

It was noted that the employees did use low pressure air to remove loose debris, sand and grit from their coveralls. Many were noted pointing the nozzle directly to their face shields and/or goggles, instead of at an angle. When pointing the nozzle at an angle, air forces loose dust away from facial areas and not onto or under protective equipment. Many of the painters, after blowing down, would immediately wipe their face with a clean cloth to remove particles that had become embedded into facial areas. It was at this point that the potential for eye injury increased, because the safety glasses or goggles were removed prior to wiping.

Taking note of the employees actions, coupled with the numerous amount of lines in the immediate work areas, the Project Engineer recommended the use of full face cartridge respirators to eliminate the number of airlines in a work area, provide workers with an environment to breathe clean air, and eliminate the potential for eye injuries during blowing down or performing mechanical cleaning. Full face cartridge respirators provide the user with clean air (providing the filters are not clogged from contaminants)while mechanical cleaning and eliminate dust from getting under safety glasses, face shields or goggles. Additionally, the bulkiness of goggles and face shields will no longer be a burden for the worker.

The decision was made by Mario Cosio, Paint & Blast Ass't Superintendent, to purchase full face cartridge respirators for testing in the on block and on board areas. Each employee was fitted with a respirator and allowed to continue his or her regular duties. After a few more weeks of observation, it was noted that setup and breakdown time for the painters and blasters decreased an average of thirty minutes per employee. Not only were differences noted with setup and breakdown times but eye injuries began to decrease in the Paint & Blast areas.

In 1997, the injury rate for Blast and Paint declined to four workers compensation cases and in 1998, there are no recorded worker compensation cases for the Paint and Blast department (as of June 1998). **(Figure 1.)** Though, a small adjustment was made in the processes to reduce or eliminate eye injuries, daily followup on your employees is vital for continued success.

RECOMMENDATIONS

Before selecting personal protective equipment, evaluate the level of protection required by your operations. The eye protection and respirators suggested for usage in atmospheres where airborne particulates pose potential health and safety concerns are only basic recommendations. When using cartridge type respirators, the following information should be considered for maximum efficiency:

1. Respirators

Particulate Filters

The selection and use of particulate respirators are on the basis of service times. Use and reuse of the P-series filters would be subject only to considerations of hygiene, damage, and increased breathing resistance. Recent studies indicate the efficiency of P-series filters may be significantly reduced with long term use in the presence of oil aerosols. In some workplace situations, this reduction in filter efficiency may not always be accompanied by an increase in breathing resistance that would signal the user to replace filter or filter element. Different levels of reductions vary from model to model, therefore selection, evaluation and testing should be thorough.

a. R-series filters should be used only for a single shift (or for 8 hours of continuous or intermittent use) when oil is present. The determination would need to be applied when conditions change or modifications are made to processes that could change the type of particulate generated in the user's facility.

b. P-series should be used and reused in accordance with the manufacture's time-use limitation recommendations when oil aerosols are present. P-series filters should be used and reused subject only to considerations of hygiene, damage, and increased breathing resistance if oil aerosols are not present.

c. 30CFR part 11 filters should be replaced at least daily or more often if breathing resistance becomes excessive or if the filter suffers physical damage (tears, holes, etc.) Filter elements designed to be cleaned and reused should be cleaned at least daily in accordance with the manufacture's instructions. Between uses, filters should be packaged to reduce exposure to conditions which causes filter degradation, such as high humidity.

2. Respirators

Air-Line Respirators (Air Supplying) supply clean air through a small diameter hose from a compressor or compressed air cylinders. The wearer must be attached to the hose at all times, which limits mobility. Use of these respirators is subject to the manufactures guidelines.

Full-Face Respirators operate under the same principles and requirements as the half-face type, however, they offer a better facepiece fit and also protect the wearer's eyes from particularly irritating gases, vapors and dust particles.

3. Eye Safety

a. Observe eye safety signs and procedures.

b. Always wear appropriate ANSI Z87 approved eye protection in clean and serviceable condition for mechanical, chemical, biological or radiant energy levels.

c. Never wear contact lenses where smoke, dust, and chemical fumes exist.

d. Know where the eye wash fountain is and know how to use and maintain it.

e. Know basic first aid for eye injury so you may help yourself and your fellow worker.

f. Have an eye examination by your eye doctor every two or three years, or sooner as directed, to ensure you have good vision to do your job safely and efficiently.

g. Report to your supervisor hazards and unsafe practices that may cause eye injury.

h. Encourage your fellow worker to practice eye safety and receive annual eye safety training.

i. Use common sense in all activities potentially hazardous to the eye.

APPENDIX 1.

1996 and 1997 Blast and Paint Worker's Compensation Costs

Actual Incurred Costs of Eye Injuries

Year	Total Blast and Paint Employees	Number of Injuries	Total Cost	Injury Rate
1996	250	15	$2,214.00	6.00%
1997	283	4	$1,059.14	1.41%

1997 Blast and Paint Eye Injury Cost Savings at 1996 Injury Rate

1996 Injury Rate	1997 Employees	1997 Per Inury Rate	1997 Cost Savings
6.00%	283	$264.88	$4,497.66

1997 Injury Rate	1997 Employees	1997 Per Injury Rate	1997 Cost Savings
1.41%	283	$264.88	$1,059.14

			$3,438.52

********* Annualized Cost Savings*********

DELIVERABLE D

BLAST AND PAINT DEPARTMENT ENVIRONMENTALLY COMPLIANT SPRAY EQUIPMENT

TABLE OF CONTENTS

SUMMARY

The research with environmentally compliant spray equipment is to reduce airborne emissions (VOC's) from the coating application process (spray painting). The process is designed to identify, test and streamline spray equipment to reduce paint usage, reduce smog causing voc emissions, improve transfer efficiency, and reduce paint wastes in U.S. shipyards. Most U.S. shipyards and foreign shipyards currently use traditional air-atomized spray painting guns for their coating applications. Some facilities utilize the Powder coating or Flame spray process to apply specialized coatings, but on the average the preferred process is the air-atomized gun. Over the years, this process has become expensive and time consuming as companies strive for compliance to mandated EPA, OSHA and local district air quality regulations.

Under pressure from environmental authorities and upper management to reduce voc emissions, coating manufactures are producing coatings that are low in voc emissions, which by the way are increasing in cost as new formulations are developed due to the complexities of certain marine coatings for tanks, underwater hulls, bilges, fresh water tanks and Cht tanks (waste tanks). Because of rising costs, it is wise for U.S. shipyards to take a proactive approach to minimizing coating, man-hour and equipment expenditures.

BACKGROUND

The traditional air spray gun, such as airless and conventional is not about to disappear from the industrial scene any time soon, because there are more of them in production activities than any other type of device for spraying liquid coatings. Most spray equipment manufacturers and environmental agencies predict that this staple of our industry will be essentially eliminated in the next ten years and replaced by spray guns that offer higher transfer efficiency. Transfer efficiency rates the ability of spray painting equipment to put paint on the parts being painted rather than allowing it to escape as overspray or in other forms of paint waste. If you use conventional spray equipment for example to apply ten pounds of paint to an uncoated surface and that surface gain two pounds as a result of being coated, you've achieved twenty percent transfer efficiency, i.e. twenty percent of the paint ended up on the part and the rest landed on booths, walls, containment, hangers and clothing (80% loss).

Paint is not the only cost associated with poor transfer efficiency. Open air spraying, as performed in most shipyards, requires purchasing and setting up of spray containment equipment which often equals the cost of the paint. Plus the generated waste is either difficult or very expensive to dispose of. Despite all the pressure to eliminate voc's, coatings thinned with organic solvents will continue to be used in the shipbuilding industry because of customer specifications or individual yard specifications.

It is quite evident that in the shipbuilding industry, requirements make it difficult or expensive to change overnight from "tried and true" air applied conventional-solvent thinned coatings and configurations of vessels make it difficult to coat with certain types of equipment that lessen voc's and improve transfer efficiency.

U.S. shipyards spend an enormous amount of money on coatings and coating applications. As environmental regulations tighten and finishers continue to search for ways to cut cost, the trend is clearly towards higher transfer equipment and alternative coatings.

TYPES OF ENVIRONMENTALLY COMPLIANT SPRAY EQUIPMENT

Most of the alternatives to conventional air spray guns would never have been invented had it not been for the relatively poor transfer efficiency of air-atomized spray. Two of the most common replacements, electrostatic application and airless spray, were commercialized long before the advent of the Environmental Protection Agency (EPA). The driving force was to reduce overspray (and cost of paint). There was certainly room for improvement, since conventional air-spray guns can waste 60-80 pct of the paint purchased.

The major types of spray equipment in use today are as follows:

- Conventional Spray Guns
- Airless
- Air-Assisted Airless Spray gun
- High-Volume Low-Pressure Spray gun
- Electrostatic Spray gun
- Plural-Component Spray gun
- Air-Assisted Electrostatic Spray Gun

In this section several types of spray gun used to apply liquid coatings will be identified, noting advantages and disadvantages. In order to properly examine, test and evaluate spray equipment, you must first identify coating requirements and specifications. The research provided in this section gives baseline data for evaluating the spray equipment.

1. **Conventional Spray Guns:** These are "conventional" because they have been around since the early part of this century. They were widely used before any of the others. Basically they emit a stream of paint from a small opening in a fluid nozzle. The paint is broken up into tiny droplets by compressed air emerging from jets adjacent to the fluid nozzle. Relatively high air pressures at low volumes will quickly atomize large amounts of paint.

   Despite their tendency to spray more paint into the air, on containment, clothing, and onto other parts, they remain an important tool in most painting facilities. They are versatile and can spray a class A finish on almost any surface. So even if you have one of the more efficient types of spray apparatus, you probably need a few conventional air-atomizing guns to do what the more advanced equipment will not.

a. **Advantages:**

-In the hands of a skilled operator, produces a smooth, reflective finish.

-Can be used to coat almost any shape. Using a variety of fluid and air nozzles, an operator can spray narrow bands or wide fan patterns.

-Can apply paint at high production rates on parts hanging from fast-moving conveyors.

-Are "user friendly" and most spray painters are experienced in using them.

b. **Disadvantages**

-Very poor transfer efficiency.

-Wastes paint, increases cleanup costs, emits more VOC's.

2. **Airless Spray Guns:** When you think of airless spray, think of a garden hose. It sprays water under high pressure through a nozzle. When the water emerges from the nozzle its velocity causes the stream to disintegrate into droplets as it encounters resistance from the atmosphere. The airless gun is similar in that it pressurizes paint to 3,000 psi (or higher) and forces it through a nozzle. Unlike conventional air spray, there are no jets of atomizing air to break up the paint and propel it to the surface. Atomization is dependent upon high fluid pressure.

a. **Advantages:**

-In the absence of atomizing air, less overspray and better transfer efficiency.

-Can apply paint at a high flow rate, resulting in ability to meet high-production speeds.

b. **Disadvantages:**

-Inability to break up paint into very fine droplets, thus producing a coarser spray and rougher finish.

-Nozzle wear. High velocities cause abrasive pigments in paint to wear nozzle openings as they travel through the nozzle.

-Danger of air-less injection injury. The paint emerges at such force that it can penetrate skin exposed to the spray at close range.

3. **Air-Assisted Airless Spray Equipment:** A hybrid of airless spray and conventional air-atomized spray, this kind of gun uses fluid pressures higher than those used in conventional air-atomized guns but lower than those employed in normal airless spray. Unlike normal airless guns, these guns do have compressed air jets that supply atomizing air, but the air pressure is far lower than that used in conventional air-atomize guns. The result is that the coarse spray provided by the airless atomization is further broken up into a finer spray by the compressed air.

In operation, air-assisted airless guns provide atomization much better than is normal with airless spray. The finish quality and production equals that of air-atomized spray. Danger of airless injection is lessened, as is wear of fluid nozzles.

a. **Advantages:**
-The main reason for considering use of air-assisted airless spray, however, is its much better transfer efficiency. The softer spray also makes it easier to spray into recesses. Both air-assisted and pure airless spray operate at high fluid pressures and thus can use smaller-diameter fluid lines. This translates into paint and solvent savings because it takes less solvent to flush smaller-diameter lines.
-Lower pressures required to pump High Solid coatings.

b. **Disadvantages:**
-An extra airline required for spray gun.
-Getting the operator of an airless gun used to lower pressure requirement of air-assisted airless.

4. **High-Volume Low-Pressure (HVLP) Spray Equipment**

HVLP is a variation of conventional air-atomize spray. The difference is that these guns are designed to atomize paint using a high volume of air delivered at low pressure. The lower pressure results in far less overspray and "bounce back."

a. **Advantages:**
-Better transfer efficiency results in less paint waste and lower cleanup costs. The exact transfer efficiency depends upon the circumstances in your installation , the part design, spray techniques, the mix of parts, etc. But most experts agree that HVLP offers significant improvement.
-Operators used to conventional guns generally find it easy to learn how to use HVLP.

b. Disadvantages:

-Atomization may be insufficient to meet the strictest requirements for smooth, fine finishes.

-May be difficult to atomize paint at sufficiently high rates to meet very high-production requirements. HVLP atomization capability has improved markedly in recent years, however, with better ability to break up low-VOC coatings being sprayed at high fluid-flow rates.

Some problems in achieving proper atomization with HVLP may be caused by "starving" the spray gun for air. Causes of this problem include use of air hoses that are too long or too small in diameter; use of too many "quick disconnect" fittings; and use of low-performance air compressors and air regulators. Any one of these factors may result in too little air being delivered to the air cap, causing poor atomization from the gun. Some of these guns use air compressors to deliver the atomizing air, while others use a turbine. The turbine is a series of fans mounted inside a housing, designed to produce pressurized air for one or more guns. In the process of forcing the air through the turbine the fans create friction and warm the air. This helps to heat the paint and in turn lowers its viscosity, thus making it easier to atomize.

5. Electrostatic Spray Equipment

Electrostatic painting begins with a spray gun or other device (discs or bells) to atomize paint. The atomizing principle could be any of those previously discussed, conventional air-atomize, HVLP, or airless.

The difference is that an electrostatic application device is equipped with a means of electrically charging the particles of paint. A common method is to build in an electrode near the point where paint is atomized. This electrode electrostatically charges the particles positively. Parts are grounded, usually by hanging or using a grounding strap securely connected to the ground. The grounded parts attract the positively charged paint particles (opposite attract).

The result is that fewer of the paint particles are propelled into space as overspray and more are electrostatically guided to the surfaces of the parts being painted. Sprayed particles will even turn the corner and be attracted to the back side of a part if the velocity of the particles causes them to initially travel past the parts being painted. This is called "wraparound".

Transfer efficiency is greatly improved. The amount of improvement depends upon the parts being painted, the design, etc. Electrostatic spray is particularly beneficial in improving transfer efficiency when parts with lots of open areas, (lacy patterns, for example) are being sprayed.

a. Advantages:

-Higher transfer efficiency.
-Coverage of edges (electrostaticly guided paint is attracted to high points and edges first).
-Uniformity of film thickness. As paint builds up on surfaces with the highest electrostatic attraction, it insulates them. Then electrical attraction increases in the uninsulated, uncoated areas, and these receive more of the paint.
-Productivity. Electrostatic guns mounted on reciprocators are widely used to paint long runs of parts in high-production installations. Labor costs are lower.

b. Disadvantages

-Faraday-Cage Effect. As mentioned previously, electrostatically charged particles seek out the nearest grounded surface. If that happens to be the ridge area of a sculptured part, the valley may be difficult to reach. For this reason, manual touchup with non-electrostatic guns may be necessary.
-Changes appearance of metallics. Many paints, especially those used in automotive finishing, contain metallic flakes that give the finish metallic sparkle. The visual effect is different if the particles are applied electrostatically, since they are conductive and tend to stand on edge rather then lie flat in the coating.
-Fire Hazard. If an electrostatic installation is not properly set-up, there is a danger that a spark can occur, igniting paints containing flammable solvents.
-Safety. If operators are not careful in following set-up directions, they can be electrostatically shocked.
-Ergonomics. Electrostatic guns traditionally have been longer and some heavier than conventional guns. Some have a bulky cable connected to them to carry the electrical current. The newer models have built in turbines that produces an electric charge once connected to air. This eliminates bulky cables and cords. Operators may find some guns more difficult and more tiring to handle, but suppliers have been working to improve ergonomics of electrostatic guns. In considering this equipment (and indeed any spray equipment) you should look not only at size and weight of the gun, but evaluate ease of trigger pull and maneuverability of the tool (with hoses) as well.
-Cleanliness. It's always a good idea to keep conveyors, spray equipment and spray booth areas clean. But in electrostatic painting it is not just a good idea; it's mandatory in order to achieve the benefits of electrostatic application. Parts must be securely grounded as they travel through the booth. This means that if they are hanging from paint-laden racks or the conveyor has picked up paint and

is becoming insulated, electrostatic attraction is lessened.
-Some coatings may require reformulation. Since the process depends upon electrical conductivity or lack thereof, solvent selection becomes more important. Some solvents are more conductive than others. In a like manner, application of waterborne coatings requires special equipment to deal with the conductivity of water. High humidity in the paint area can cause conductivity problems.

6. Plural-Component Spray Equipment

Some coatings, principally urethanes, are supplied as two components. After being mixed, the components chemically react with one another to form a solid coating. They are often referred to as "catalyzed" since the "catalyst" causes a reaction that leads to curing of the coating. An advantage is that low temperatures are sufficient to cure the coating and thus plastic parts that cannot tolerate high temperatures can be coated. The coatings also exhibit unusual durability in certain applications and require less solvent for thinning, thus improving VOC control.

If the two components are mixed before entering a paint pump or pressure pot, the mixed material must be sprayed promptly or the reaction of the two components increases viscosity to the point where the coating is no longer sprayable. It is said to have limited "pot life".

The components mix just prior to application. This remedies the "pot life" problem, since mixing occurs only at the moment before application.

Two-component application equipment is used in some very high-production applications, but not to the extent of the more conventional technologies. The reason is obvious, the equipment is more costly, as are the coating materials.

a. Advantages:

-Manpower reduction for replenishing paint units
-55 gallon drums or paint totes
-60% reduction in solvent usage
-50-70% more efficient usage
-Reduction of paint usage from batch mixing
-Reduction in solid waste disposal costs

b. Disadvantages:

-High initial cost for purchase
-Some restriction on location and placement

7. Air-Assisted Electrostatic Spray Guns

In the shipbuilding and repair industries, most areas of a ship will require different coatings applications due to different coating requirements and location of application. The gun to meet those various applications is the air-assisted electrostatic gun. This gun provides ease of usage with the convenience of applying coatings using an air-assisted or electrostatic method. Due to the Faraday-cage effect on electrostatic application, air-assisted airless application would suffice to coat hard to reach areas.

The air-assisted airless electrostatic gun increases transfer efficiency, reduces waste, reduces touchup after application, eliminates "bounce back", reduces overspray and provides ease of application with the flip a finger from one application to the other. Underwater hulls requires the use of various anti-fouling paints which cannot be applied using electrostatic, but that same gun can be used to apply that coating with a air-assisted airless application. This is an excellent gun when you are spraying various coating in succession(such as from an epoxy primer to a urethane). Multi-coat application can be accomplished easily if needed.

a. Advantages:

-Highest transfer efficiency available
-Operator versatility between applications (air-assisted airless or electrostatic)
-Excellent for coating corners and some crevices

b. Disadvantages:

-Lengthy operator training
-Operator fatigue (hand gripping)
-Larger spray gun
-Restrictions in area usage (such as using in tight or confined area radius)

EQUIPMENT EVALUATION

In order to help reduce VOC emissions, paint usage, paint waste and cost associated with spray equipment, two Air-assisted spray guns and a Electro-static gun was purchased for testing. This equipment was purchased from

Graco Inc. Graco has over the years, become a leader in research and development of Air-assisted and Electro-static technology. The guns utilized for testing were the AA Plus and the Pro A4500 Electro-static gun. Both guns will operate at higher pressures in the 3,000 to 5,000 psi range and can be used with existing equipment.

Due to NASSCO's coating requirements, I realized there would be problems with the transfer of the High Solids Low Voc Coatings to the spray guns. In order to spray this material, a Graco 41:1 Bulldog pump was purchased. The 41:1 pump is stronger than a 30:1 pump and therefore able to pump the heavier material from the paint container. A few problems associated with high solid coatings are high viscosity and density. Because of this, larger pumps, heaters and longer mixing times are required for effective transfer of the coating. The idea behind using a larger pump is quite simple; if you are able to pump the coating, you can atomize it at the spray tip without clogging and damage to pump cylinders.

1. AA Plus Air-Assisted Spray Gun

The AA Plus has been designed to atomize high solids coatings at higher pressures while providing an excellent finish for air-assisted applications. The AA Plus is readily adaptable to your existing airless or air-assisted finishing equipment without major changes to your operation. When changing from competitive air-assisted or airless guns, the painters will appreciate the light trigger pull and comfort of the AA Plus.

The AA Plus is available with the new Reverse-A-Clean tip, air cap and housing for difficult applications that require the benefits of air-assisted airless. The AA Plus delivers less bounceback, lower overspray, better film control and higher transfer efficiency than conventional airless spray guns.

The AA Plus has improved air caps and tips which has enhanced atomization and consistency for production needs. The gun requires minimal force to pull the trigger, due to an improved design. If you need to improve transfer efficiency and are using high solid coatings, this air-assisted gun will give satisfactory results.

2. Pro 4500 Electro-static Spray Gun

This gun combines the convenience of Air-assisted airless power with the versatility of selective voltage control of electrostatic spray. For coatings that are low in electro-static charge, this gun can be adjusted to 85KV for compensation of electrical charge. You can deliver up to 85KV of electrostatic charge (or adjust to a preset lower voltage) by simply flipping a switch. All essential controls are located right at the back of the gun.

Other electrostatic systems require constant pacing between the power supply and the gun to alter the voltage setting. But the Pro 4500 uses factory air to generate its electrostatic charge inside the gun. No external power supplies or power cables are required.

The voltage setting of this gun can be monitored up to distances of ten feet. The Pro 4500 reports actual spraying voltage to the hand held spraying voltage readout (svr, optional equipment) remote monitor. This gun is a self-generating electrostatic gun, equipped for versatility of voltage control. Voltage control is important because it allows the user to maximize its high transfer efficiency capabilities in applying low charged coatings.

Compliance: This gun meets the most stringent air quality equipment rules, including South Coast Air Quality Management District Rules 1124, 1136 and 1151. In addition, the optional SVR remote monitor allows you to verify compliant electrostatic operation at any time.

Simplicity: The Pro4500 can be installed on your finishing line in only a few minutes with no special equipment. (Knowledge and practice of electrostatic painting and safety techniques are required.)

Efficiency: The transfer efficiency of the Pro4500 matches or exceeds the capabilities of other electrostatic guns in critical performance tests.

Versatility: The Pro 4500 voltage control enables the operator to adjust voltage up or down to maximize electrostatic efficiency. In constricted part areas where Faraday-Cage effect is present, electrostatic voltage can be reduced or turned off right at the gun to perform complete paint coverage.

Maneuverability: This is an excellent painters' gun, expressly built to handle the rigors of industrial finishing, while providing the balance and feel that minimizes operator fatigue over long duty cycles.

Control: This user-friendly gun brings electrostatic control back to the gun. With a simple flick of the thumb, an operator can activate electrostatic power and also adjust the level of electrostatic effect. Fan pattern and fluid control are also conveniently located at the back of the gun for maximum control.

CONCLUSION

Painters who are used to conventional and airless spray will experience difficulty in converting to the new equipment, but changeover can be achieved with a proper amount of training. Electrostatic spray is still currently a source of fear for painters that are conditioned to air or airless spray. With proper indoctrination on safety, spray techniques and education on electrostatic spray technology, operator fears will ease. Most painters will associate intense electrical shock with liquid coatings and refuse to use the equipment.

The majority of NASSCO's painters who used the equipment were receptive for the most part, but again, most were very hesitant. Their comments included such statements as, the electrostatic guns are too delicate, productivity is decreased with electrostatic use, and it takes too long to set-up equipment. The use of electrostatic equipment leads to a decrease in production painting speed, but the decrease in overspray, better mil thickness adherence, decrease in solvent usage and increased coating coverage outweighs production speed.

The airless spray gun is much higher in production speed and rate. Most painters have been trained with this particular gun and the learning curve required for re-training on an electrostatic gun is tremendous. This gun will apply paint at a much faster rate in less time than any gun on the market. Even though production rates for application is much better for airless guns, overspray, over millage of paint (build up of paint on a surface that causes exceeding mil thickness), coarser and rougher finishes and less operator control for applying fine finishes makes this gun inefficient for quality finishes. Runs, sages, and orange peel (coating separation) are common occurrences with airless guns especially in tight and confined spaces. Due to today's cost's for epoxies (from $7.00 to $19.00 per gallon) which is used in all shipyards to some exodic finishes up to or exceeding $45.00 per gallon; It makes good dollars and sense to use application equipment with a higher transfer efficiency. **(Figure 1)**

Air-assisted airless spray was more acceptable to seasoned painters because it provided a combination of airless and conventional spray familiarity. The air-assisted airless guns tested eliminated complaints that the spray tips weren't easily changeable. The current guns are equipped with a reversible tip to meet the most stringent production requirements. The painters discovered that these guns could be effectively used from the same paint pump without a changeover to another pump. Changeover of spray equipment is time consuming during a spray operation and therefore any equipment that will blend into your current process will effect employee buy-in.

Air-assisted airless guns can be utilized on shipboard areas where airless equipment is currently used. The application of high solid primers and topcoats by air-assisted

airless can effortlessly be accomplished using the same processes and procedures used for airless application. Electrostatic guns provide opportunities for exterior application of topcoats such as urethanes, acrylics, alkyds and epoxies. Most shipbuilding companies accomplish paint activities outside. This is an ideal application method to reduce airborne contaminants and lessen overspray damage to machinery, automobiles and other structures. **(Figure 2)**

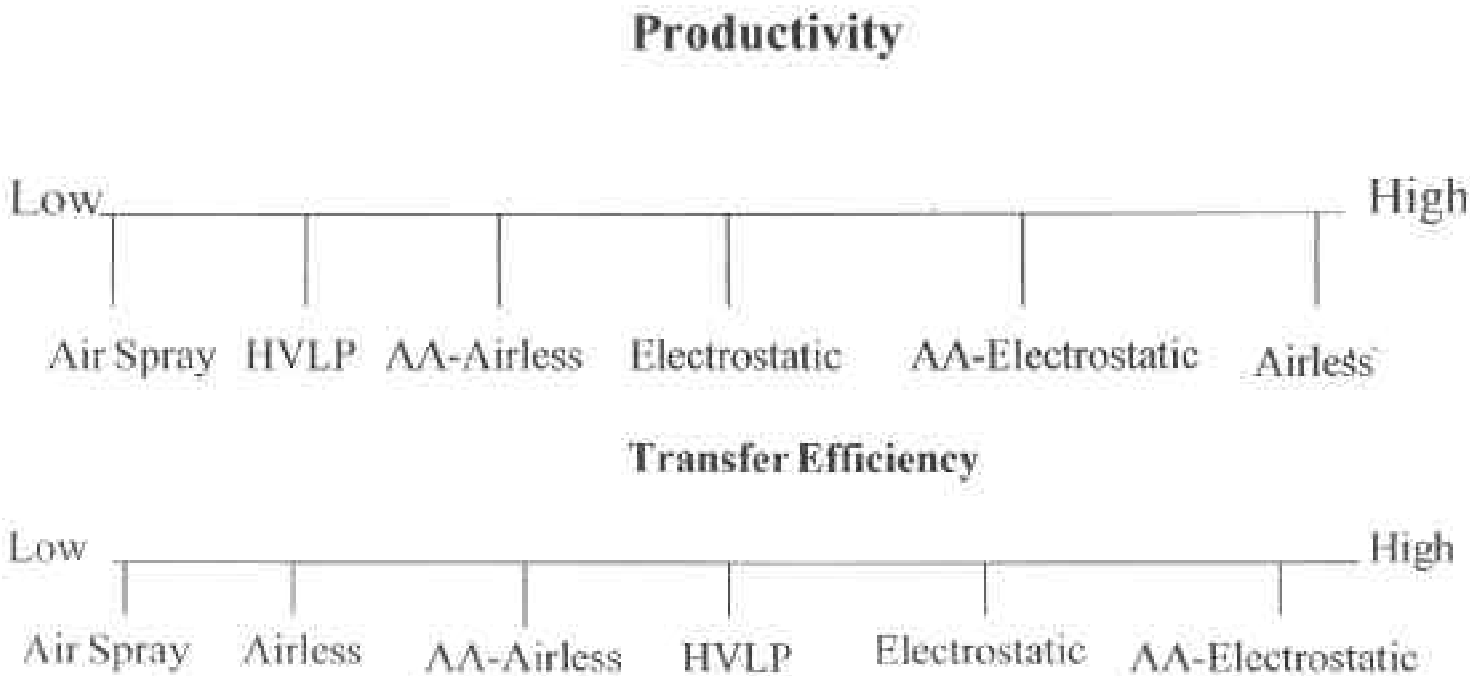
Air-assisted airless electrostatic provides the highest in transfer efficiency because of versatility and user choice of application. This equipment will apply coatings to adherent mil thickness with a smoother finish. Overspray is reduced primarily because of electrostatic technology and Faraday-cage effect is significantly reduced because an operator can use the air-assisted airless function to spray tight or confined spaces. With today's rising costs for coatings, solvent and disposal, it makes sense to use application equipment that apply's paint to the manufactures coverage specifications. **(Figure 1)**

Transfer efficiency should be a driving factor in spray equipment purchases. Care must be taken in examining the equipment manufacters claims in transfer efficiency by extensive testing and training. The transfer efficiency rates given below are approximate rates achieved in testing in a marine environment and will vary according to conditions and environment of actual application. **(Figure 3)**

There is much trial and error associated with the use of environmentally compliant spray equipment. Company management is hesitant to purchase this equipment because of cost factors, training and time requirements needed to familiarize their painters with the new technology. **(Figure 4)** Equipment cost are high initially, but long term benefits outweigh the initial costs. With any type of new equipment or procedure, time and effort are needed to ensure success.

Figure 1

Productivity and Transfer Efficiency Rankings



Paint and Blast Department
Compliant Spray Equipment

- **Electrostatic usage areas**
  Exterior surfaces; bulkheads, decks, side shells, interior storage spaces, cargo areas, etc.

- **Air-assisted airless usage areas**
  In all areas where current usage of airless guns are used

Paint and Blast Department
Compliant Spray Equipment

- **High volume low pressure guns**
  Can be used in areas where current usage of conventional spray is used

- **Air-assisted airless electrostatic guns**
  More versatility than regular electrostatic guns to spray areas where Faraday cage effect is of concern

Figure 2 cont'd Del. D NSRP 0526

Paint and Blast Department

- **Transfer efficiency rates:**

- Electrostatic	45 -- 75%
- AA-Airless	70%
- Airless	20 -- 40%
- Conventional	15 – 30%
- HVLP	50 – 75%
- AA-Electrostatic	70 – 90%

Cost Comparisons for Spray Equipment

• Electrostatic	• $1,800 - $2,500
• AA-Airless	• $300 - $450
• Airless	• $35 - $65
• Conventional	• $17 - $28
• HVLP	• $175 - $230
• AA-Electrostatic	• $3,500 - $4,500

DELIVERABLE E

STEEL ERECTION

SUMMARY

Steel erection encompasses all of the on-board construction of the ships. This area is responsible for the erection of fabricated units from the on-block assembly area. Due to the nature of work in this area, there is variety of trades involved in the on-board erection process. The trades assigned to this department are, Shipwrights, Shipfitters, Pipe welders, Line-heaters, Layout W&O and P&S, Fire watches, Code Welders, Welders, Chipper, and Burners. Other activities such as launching are also included in their processes.

Since 1995, the steel department has cost NASSCO the most money in regard to workers compensation costs. Of all reported workers' compensation injuries, back injuries were the most expensive injury. Steel erection costs for workers' compensation for back injuries totaled $1.4 million during a two year (1995 & 1996) time-frame. Because shipfitters and welders are the most numerous of the trades represented in the steel erection group, they had the most back injuries and were selected for study.

The nature of work required for Shipfitters and welders, such as cutting, grinding, lifting strongbacks, lifting turnbuckles and ripout of shipboard structures, was the major cause of injuries for these trades. Additional job duties include repetitive or prolonged bending, stooping, kneeling, squatting, climbing, lifting of welding equipment, handling pipe, carrying equipment, and lifting from fifty (50) to seventy (70) pounds in awkward, contorted positions.

In 1996, NASSCO instituted measures that changed work processes and procedures. These measures increased productivity, and increased safety awareness. During this time, NASSCO instituted a stretching program throughout the shipyard that began to gradually decrease injuries and increase employee awareness of safety in steel erection for 1995/96. The steel erection back injury rate was at 40.2% in 1996. In 1997 the rate was at 15.3%. Currently the rate is at 11.5%.

In 1997, steel erection began to realize injury and cost reductions, due primarily to the stretching program, increased education and training on back injuries. Additionally, steel erection witnessed cost and injury reductions in part, because of the process improvement team efforts. Saving estimates for 1997 and 1998 are based on page 18-see below. The 1998 savings and rate projections are based on annualized figures of five months. **(Figure 1.)**

PARTICIPANTS

Due to injuries and the tremendous amount of money spent each year on workers' compensation costs, Bob Hillstrom, Steel Erection Manager assembled a process improvement team to help reduce injuries. IN order to get honest and unbiased opinions from the team members, it was decided to leave supervision off the team. The steel erection team consisted of only hourly employees.

During the first meeting, Bob reviewed such information such as, safety statistics, NASSCO safety record, safety costs. It was explained to each member of the team why they were selected. Bob explained to the project engineer and team facilitator, that he would give clarification and /or understanding of any suggestions or terminology, made by the team. Andre Dorais, facilitator, from the training department suggested the following guidelines for the team: **(1) Identify Problem, (2) Charter- what are we doing here?? define mission, (3) Identify roles of each team participant.** Each team member had the option of resigning from the team if he was uncomfortable in this role.

Each team member was selected because of skill level, length of time in the trade, evidence of being a team player, and have a good reputation with co-workers. Another important aspect, was that they had the respect of their co-workers regarding their communication and trade knowledge. The members were also selected because of their dedication to safety and their total personal safety record.

After preliminary information was disseminated to the group, the team charter was distributed and discussed.

TEAM CHARTER

> **Review injury and workers' compensation data for 1995 through present, select one injury type (body part) which consistently reoccurs, causes pain and suffering to employees and has a significant cost impact on the company, analyze the causes of the injury chosen, support and assist in the implementation of your recommendations with co-workers.**

TEAM PARTICIPANTS

Name	Position	Work Area
Pete Castro	Shipfitter	Steel Erection
Louis Fraire	Shipfitter	Steel Erection
Carlos Castro	Shipfitter	Steel Erection
Stanley Szumilas	Welder	Steel Erection
German Magadia	Welder	Steel Erection
Ernie Alvarado	Shipwright	Steel Erection
Andre Dorais	Facilitator	Paint & Blast / General Services
Bob Hillstrom	Manager	Steel Erection
Tony Walsh	Design Engineer	Engineering
Freddie Hogan	Project Engineer	Human Resources

BACKGROUND

Because these team members were from the production areas,and had not recieved any formal training in team interaction, the facilitator decided to teach team building skills. Early evidence of this lack of training, was when ideas were generated, other team members began to add input without documenting ideas. During the early meetings, the facilitator closely monitored the comments, ideas, suggestions, and feedback to keep the team members on track. Each week, the team members rotated team positions such as, timekeeper, team leader, and scribe in order to experience the whole team building concept.

After a couple of months, the team members gradually the skills of team building. The team members met once a week so they would not get discouraged, but get accustomed to the idea of meeting regularly. An agenda was set up prior to the meeting, so that each member knew what was to be discussed during the meeting and therefore came prepared if they had assignments. During the early meetings, the team performed weighted voting of ideas to narrow the field of ideas into a manageable categories. Video presentations were presented that demonstrated learning points such as: cause/effect diagrams elements, steps in creating diagrams, how teams work together to create one. Additionally, the team used a fishbone or cause and effect diagram to help narrow the field of ideas.

The eam identified back injuries as the **effect,** and six categories of causes for the effect: People, Materials, Equipment, Environment, Methods, Training. The team decided to concentrate on two categories "People and Training" after initial voting indicated that preference on the part of the team. After considerable discussion , the team decided to concentrate on the "people" issue and assume that the "training" concerns might be part of the solution to the problem of back injuries. After even more debate, the team tentatively agreed that **"bad lifting practices"** was the base cause of back injuries with other probable causes as associated with lifting. **(Figure 2. & Figure 3.)**

Jim Ferguson, NASSCO's Industrial Hygienist, defined "soft tissue" for the group. He explained the relationship among the muscles, tendons, ligaments, cartiledge, and bursers and how they are affected by various activities. Some of the key points of the presentation included: FROI (first report of injury) information shows where problems lie and suggest areas to put our training and dollars to work; look at the job and see why people may be working beyond their capabilities (as it relates to overexertion); how stretching/warmup exercises are very good for soft tissue, energize blood flow and contribute to alert and good spirited workers. He further explained "FROI" terminology as it relate to soft tissue injuries. Explanation of the FROI terms such as: "overexertion"," repetitive motion", and "not classified" were given for informational purposes.

Cost of Back Injuries

During the 1995/96 loss period, the steel erection group had a back injury rate of 40.2%. In other words, if the department had 100 employees, then forty of them would have had a back injury during the year. The cost of these back injuries in one steel erection group for the two year time period was $1,255,668 or over $600,000 per year.

After the steel erection process improvement teams began studying one injury statistics and implementing recommendations, the 1997 back injury rate went down to 15.3% and the 1998 rate is on an annualized basis at 11.8%. Saving estimates for 1997 and 1998 are based on page 18- see below.

Causes of Chosen Injury

The team began to analyze the causes of back injuries in steel erection. The group talked about "at risk" and "acceptable" behaviors and identified the following at risk and acceptable behaviors:

At Risk Behavior	Acceptable Behavior
Rushing your tasks	Proper planning
Poor housekeeping	Use of teamwork and greater emphasis by supervisors to improve housekeeping.
Bad attitude/Stress	Proper communication, respect for co-workers, and controlling anger
Bad lifting practices, lifting beyond limitations, improper body position	Proper training in lifting practices, use of proper equipment
Ignoring safety rules	Following safety rules
Improper warm-up	Morning warm-up exercise, proper exercise
Repetitive motion, lack of breaks or rest	Alternate tasks
Cramped areas	Alternate tasks
Bad physical condition	Good physical health, proper exercise
Failure to notify supervisor of previously existing condition (past injury)	Proper communication

After "at risk" and "acceptable behaviors" were identified, a discussion was held on why people put themselves at risk. The following barriers to at risk behavior was discussed: **Readiness...**The ability to respond correctly to a safety challenge or situation. From group observation there were three stages to readiness such as:

1.) Starting a new job, concern is high but knowledge and skill are low resulting in low readiness.

2.) Concern has dropped but knowledge and skill have improved resulting in

high readiness.

3.) Concern is low and knowledge have plateaued so readiness drops.

Observation Process

Once it was decided that the group would investigate back injuries, the team immediately made preparation to do observations. The observations consisted of watching their co-workers during the course of the day performing job assignments. It was agreed that, everyone would make one observation a day. The group not only observed safe lifting practices but also noted unsafe lifting practices. These observations were performed in order to test the group's hypothesis that bad lifting practices were causing back injuries in steel erection . The group conducted observations to analyze trends in lifting practices. The group decided to continue performing observations in order to obtain valid conclusions. **(Figure 4. & Figure.5.)**

The group initially agreed to perform 500 observations, but as the team members began to work in different areas of the yard, over sixteen hundred (1,600) observation were done. From July 1997 to September 1997, the team collected observation data and discovered that steel erection were performing safe lifting practices fifty one percent (51%) of the time. **(Figure 5.).** So as not to make workers cautious or nervous, the observations lasted approximately two to three minutes.

The data was collected and charted for patterns and consistency to note any unusual trends towards other possible causes of back injuries. The data was analyzed weekly for group discussions and possible intervention to increase the percentage of safe behaviors. Once the team members were trained in the "DO IT" process, observations were again conducted from December 1997 until March 1998. The percentage of safe behavior increased from fifty-one (51%) to seventy-one (71%) percent after a second set of 1,600 observations. **(Figure 5.)**.

Behavior can be managed at the organizational level by systematic application of the DO IT process. In other words, disirable (e.g., safe) behavior can be increased or undesirable (e.g., at-risk) behavior can be decreased, and the impact of a behavior change intervention can be evaluated objectively by following the steps represented by the DO IT acronym: **D =** Define the target behavior, **O =** Observe occurences of the target behavior, **I =** Intervene to change the frequency of the target behavior in desired direction, and **T =** Test the impact of the intervention strategy by continuing to record occurences of the target behavior.

1. **Define** the target behavior. [What behavior do you want to decrease or increase?]

2. **Observe** the target behavior. [How will you observe the target behavior?]

3. **Intervene** to change the target behavior. [What intervention techniques will you use to influence the target behavior?]

4. **Test.** [What data or information will you use to test the impact of your intervention?]

Rewards and Recognition

Employees understand what is expected of them. If rewards/recognition are based on production, employees do what it takes to get the job done which may include taking risks. Rewarding production without equal emphasis on safety will cause safety to suffer. Employees will perform their work based on rewards and ignore safety to attain the rewards. (jackets, cups, hats, etc.)

It has been researched and reported (Geller. 1997), that we learn from success than failure. Behavioral scientist have shown quite convincingly that success--not failure--produces learning. Edward Lee Thorndike, for example, studied intelligence at the start of this century by putting chickens, cats, dogs, fish, monkeys, and humans in situations that called for problem solving behavior. Then he systematically observed how these organisms learned. He coined the "Law of Effect" to refer to the fact that learning depends upon behavioral consequences. When a behavior is followed by a "satisfying state of affairs" the probablility of that behavior occurring again is increased. But, if an "annoying state of affairs" follows a behavior, that behavior (considered an error) is less likely to occur again. With this in mind lets consider the following seven steps of quality recognition.

1. Deliver it during or immediately after safe behavior.

In order for recognition to provide optimal direction and support, it needs to be associatied directly with the desired behavior. People need to know what they did to earn the appreciation. Then they are motivated to continue that behavior. If it is necessary to delay the recognition, then it is important to relive the behavior or activities that deserve recogniton. Reliving the behavior means talking specifically about the performance warranting special recogniton. Don't hesitate to ask the recipient to describe aspects of the situation and the desirable behavior. This assures direction and motivation to continue the desired behavior. Connecting a person's behavior with recognition also makes the recognition special and personal for the recipient.

2. Make it personal for both parties.

Recognition is most meaningful when it is perceived as personal. Recognition should not be general appreciation that could fit anyone in any situation. Rather, it should be customized to fit the particular individual receiving it. This happens naturally when recogniton is linked to the individual's performance under designated circumstances.

3. Connect specific behavior with general higher level praise.

Recognition is most memorable and self-esteem boosting when it reflects a higher-order characteristic. Adding a universal attitude like leadership, integrity, trust-worthiness, or actively caring to the recognition statement obviously makes the recognition more rewarding. But it's important to state the specific behavior first, and then make an obvious linkage between the behavior and the positive attribute it reflects.

4. Deliver it privately and one - on -one.

Because quality recognition is personal and indicative of higher-order attributes, it needs to be delivered in private. After all, the recognition is special and only relevant to one person. So it will mean more and seem more genuine if given from one individual to another.

It seems conventional to recognize individuals in front of a group. This approach is typified in atheletic contests, as witnessed worldwide in the 1996 Olympics.

Many managers take the lead from these events and give their individual recognition in group settings. Indeed, isn't it maximally rewarding to be held up as an exemple in front of one's peers?

We need to realize that many people feel embarrassed when identified in a group setting. Part of this embarrassment could be due to fear of subsequent harassment by peers. Some peers might call the recognized individual an "brown noser" or accuse him or her of "sucking up to management."

It is beneficial, of course, to recognize teams of workers for their accomplishments, and this can be done in a group setting. Usually group accomplishment worthy of recognition can be documented for public review. And, since individual responsibility is diffused or dispersed across the group, there is minimal risk of individual embarrassment or later peer harassment. However, it's important ot realize that grou achievement is rarely the result of equivalent performance from all group members. Some individuals typically take the lead and work harder, while other do less and count on the group effort to make them look good. Thus, it's important to deliver personal and private recognition to those individuals who went beyond the call of duty for the sake of their team.

5. Let it stand alone and soak in

A psychologist has recommended a "sandwich method" for enhancing the impact of interpersonal communication. "First say something nice, then give corrective feedback, and then say something nice again." This approach might sound good, but is is not supported by communication research. In fact, this mixed message approach can cause confusion and actually reduce credibility. The impact of initial

recognition is canceled by the subsequent correction, and then the corrective feedback is neutralized by the closing recognition. Keep recognition simple and to the point, and give your behavior-based praise a chance t soak in.

In this fast track age of trying to do more wtih less, we all try to communicate as much as possible when we finally get in touch with a busy person. After recognizing a person's special safety effort, we are tempted to tag on a bunch of unrelated statements, even a request for additional behavior. This comes across as "I appreciate what you've done for safety, but i need more." To give quality recogniton, you need to resist the temptation to do more than praise desired behavior. If you have additional points to discuss, it's usually best to reconnect later after the rewarding recogintion has had a chance to be internalized and become a part of the individual's self-recognition system. By giving quality recognition we give people a script they can use to reward their own behavior. In other words, our quality recogniton strenghens the other person's self-reward system.

6. Use tangibles for symbolic value only.

Tangibles can detract from the self-recognition aspect of quality recognition. If the focus of a recognition process is placed on a material reward accompyning the social approval, the words of appreciation cand become less significant. And in turn, the impact on one's reinforcement system is lessened.

Tangibles can add to the quality of interpersonal recogniton if they are delivered as tokens of appreciation. If they include a safety slogan, tangibles can help to promote safey. But how you deliver a trinket will determine wherther it adds to or substracts from the long-term benefit of your praise. The tangible must not be viewed as a payoff for the safety-related behavior, but only as symbolic of going beyond the call of duty for safety.

Even in a behavior-based safety incentive program, the tangiblesshould not be considered fair compensation for extra effort on behalf of safety. In an incentive program, however, people know beforehand what they need to do to earn a certain tangible reward. That's the incentive. In contrast, recognition is a reward without and incentive. An individual is caught doing right and is recognized for that behavior. And, if a tangible is presentd along with verbal praise, it should be delivered with words that give it symbolic value.

7. Secondhand recognition has special advantages.

Up to this point, I've been talking about one-on-one verbal communication in which one person recognizes another for a particular safety related behavior. It is also possible to recognize a person's outstanding efforts indirectly, and such and approach can have special benefits. Suppose, for example, you overhear metalk to another person about your outstanding safety presentation. How will this

secondhand recognition affect you? Will you believe my words of praise were genuine?

Sometimes people are suspicious of the genuineness of praise when it is delivered face -to - face. The recipient of praise might feel, for example, there is an ulterior motive to recogniton. Perhaps the deliverer of praise is expecting a favor in return for the special recognition. Perhaps bothe individuals had recently attended the same behavior -based safety course, and the verbal exchange is recognized as an eextension of a communication exercise and thus devalued as sincere appreciation. Secondhand recognition, however, is not as easily tainted with these potential biases, and thus its genuineness is less suspect.

My main point here is that gossip can be beneficial--if it is positive. When we talk about the acievement of others is in behavior-specific terms, we begin a cycle of positive communication that can support desired behavior, as well as build internal systems of self-recognition. We also set and example for the kind of interpersonal communication that builds self-esteem, empowerment, and group cohesion. These are the very person states that increase actively caring behaviors and cultivate the achivement of a Total Safety Culture.

For additional information regarding recognition as it relates to safety, please refer to Scott Geller's, **Actively Caring for a Total Safety Culture Seminar, 1997:** Quality Recognition: Key to Safety Improvement.

JOB SAFETY ANALYSIS OR JOB HAZARD ANALYSIS

Job safety analysis is a analytical tool that can improve a company's overall performance by identifying and correcting undesirable events that could result in accidents, illnesses, injuries, and reduced quality and production. It is an employer/employee participation program in which job activities are observed; divided into individual steps; discussed; and recorded with the intent to identify, eliminate, or control undesirable events.

JSA or JHA effectively accomplishes this goal because it operates at a very basic level. It reviews each job and breaks it down into an orderly series of smaller tasks. After these tasks have been determined, the same routine of observation, discussion, and recording is repeated, this time focusing on events which could have a negative impact on each step in the task. Once potential undesirable events are recognized, the process is repeated for a third time and corrective actions are identified.

Conducting a JSA or JHA can be a valuable learning experience for both new and experienced employees. Not only does it help them understand their jobs better, but it also familiarizes them with potential hazards and involves them in developing accident procedures. Workers are more likely to follow procedures if they have a voice in planning. Finally, the JSA/JHA process causes employees to think about and how it relates to their jobs.

Who Should Conduct JSA/JHA

The responsibility for the development of a JSA/JHA lies with the first-line supervision. These individuals have first-hand knowledge of the process, its potential hazards, and the need for corrective actions instituted at each step. This also provides the interaction with hourly employees necessary to complete the JSA. Initially, first-line supervisors must receive training in hazard recognition and procedures necessary to perform a JSA. This training will give them the knowledge necessary to explain the JSA to employees, what it is expected to accomplish, how it is conducted, and what their part will be in the program.

It has been proven that a well-organized and maintained JSA/JHA program can have a very beneficial effect on accident prevention, improved production, and product quality. Emphasis for this program, as with any other program, must start at the top and be conveyed down the line to all employees.

Procedures and Various Methods Used to Perform JSA's

A job safety analysis is a procedure used to review job methods and uncover hazards that:

1. May have been overlooked in the layout of the plant or building and in the design of the machinery, equipment, tools, workstation, and processes;

2. May have developed after production started; or

3. May have resulted from changes in work procedures or personnel.

The principal benefits of a JSA/JHA include:

1. giving individual training in safe, efficient procedures;
2. making employee safety contracts;
3. instructing the new person on the job
4. preparing for planned safety observation;
5. giving pre-job instruction on irregular basis
6. reviewing job procedures after accidents occur; and
7. studying jobs for work-methods improvements.

JSA's/JHA's can be performed using three basic steps, but a careful selection of the job to be analyzed is an important preliminary step.

Various Methods to Perform JSA's/JHA's

There are three basic methods for conducting JSA's. The direct observation method uses observational interviews to determine the job steps and hazards encountered. A second way to perform a JSA is using the discussion method. This method is typically used for jobs or tasks that are performed infrequently. It involves pulling together individuals who have done the job and having them brainstorm regarding the steps and hazards. The third way to perform a JSA is called the recall-and check method. This method is typically used when a process is ongoing and people can't get together or to the worksite. Everyone participating in this process writes down ideas about the steps and hazards involved in the job. Information from these individuals is compiled and a composite list is sent to each participant. Each person can then revise the list until consensus is achieved.

The following list gives the three basic approaches that can be used to determine how to perform a specific JSA/JHA.

1. By a specific machine or piece of equipment (for example: a lathe)
2. By a specific type of job (for example: welding)
3. By a specific occupation (for example: machinist)

Job Selection

A job is a sequence of separate steps or activities that together accomplish a work goal. Jobs suitable for a JSA/JHA are those which a line supervisor chooses. Jobs should not be selected at random. Those with the work accident history should be analyzed first if the JSA/JHA is to yield the quickest possible results. In selecting jobs to be analyzed and establishing the order of analysis, top supervision should be guided by the following factors:

1. Frequency of Accidents: A job that has repeatedly produced accidents is a candidate for a JSA/JHA . The greater the number of accidents associated with the job, the greater its priority claim for a JSA/JHA.

2. Rate of disabling injuries: Every job having a history of disabling injuries should have a JSA performed. Subsequent injuries prove that preventive action taken prior to their occurrence was not successful.

3. Severity potential. Some jobs may not have a history of accidents but may have the potential for causing severe injuries. The more severe the injury, the higher the priority for a JSA/JHA.

4. New Jobs: Changes in equipment or in processes obviously have no history of accidents, but their accident potential may not be understood. A JSA should be conducted for each new job. Analysis should not be delayed until an accident or near miss occurs.

After the job has been selected, the three basic steps in conducting a JSA are:

1. Breaking the job down into its component steps

2. Identifying the hazards and potential accidents

3. Developing solutions

1. Breaking the job down into its component steps

Before the search for hazards can be started, a job should be broken down into a sequence of steps, each describing what is to be done. There are two common errors in the process which should be avoided. They are:

a. making the job breakdown too detailed so that an unnecessarily large number of steps results.

b. making the job breakdown so general that the basic steps are not recorded.

To perform a job breakdown, use the following steps.

a. Select the right worker to observe. Select an experienced, capable, and cooperative person who is willing to share ideas.

b. Observe the employee performing the job.

c. Completely describe each step. Each step should tell what is done, not how it is done.

d. Number the steps consecutively.

e. Watch the operator perform the job a number of times until you are sure that all the steps have been noted.

f. Check the list of steps with the person observed to obtain agreement on how the job is performed and the sequence of the steps.

2. Identifying hazards and potential accidents

The purpose of a JSA/JHA is to identify all hazards, both those produced by the environment and those connected with the job procedure. Each step must be made safer and more efficient.

Close observation and knowledge of the particular job are required for the JSA/JHA to be effective. Job observation should be repeated until all hazards and potential accidents have been identified.

The sample worksheet **(Figure 6.)** will make it easier for the observer to make sure nothing was overlooked.

3. Developing solutions

The final step in a JSA/JHA is to develop a safe job procedure to prevent the occurrence of accidents. The principal types of solutions are:

a. find a new way of doing the job,
b. change the physical conditions that create the hazards
c. change the work procedure, and / or
d. reduce the frequency of the job.

Completion of the JSA/JHA

After completion of the worksheet, the data should be compiled and transferred to a actual JSA/JHA form. **(Figure 6.)** Once the data has been entered and verified, it is important to obtain signature approval for the JSA from an upper-level manager.

Once the JSA/JHA is completed, it should be discussed with those employees performing that job. Any necessary safety procedures or additional safety equipment required to perform the job should be reviewed with these employees. In addition, a copy of JSA/JHA should be available for the employees to use when they perform the job. This is particularly important for those jobs that may not be done on a regular basis. It is important to note that no job is static. JSA's/JHA's should be reviewed on a regular basis and any necessary changes should be made.

The major benefits of a JSA/JHA comes after its completion. Supervisors can learn more about the jobs they supervise. Employees who use JSA's/JHA's have improved safety attitudes and their safety knowledge is increased. Supervisors can also use JSA's for training new employees. JSA's provide a list of needed steps to perform the job, as well as identifying the procedures and equipment needed to do the job safely.

The JSA's/JHA's can furnish materials for planned safety reviews. All the steps in the JSA should be followed with an emphasis on the major safety hazards. Supervisors should occasionally observe employees as they perform the jobs for which the analysis has been developed. If any procedural deviations are observed, the supervisor should alert the employee and review the job operation with them.

Figure 1.

1997 STEEL ERECTION WORKERS' COMPENSATION COST SAVINGS (BACK)

Year	Number of Employees	Total Injuries	Injury Rate Per 100 Employees	Total Cost of Back Injuries	Rate Difference from Base	Total Cost Savings per 100 Employees
1995/96	383	154	40.20%	$627,834.00		
1997	235	36	15.30%		61.94%	$238,323.00
1998 (annualized	187	22	11.80%		70.65%	$216,737.00

******NOTE***** 1997 and 1998 Cost Savings calculated using 1995/96 headcounts and injury costs. This was done to isolate the injury rate as the only changing Variable.**

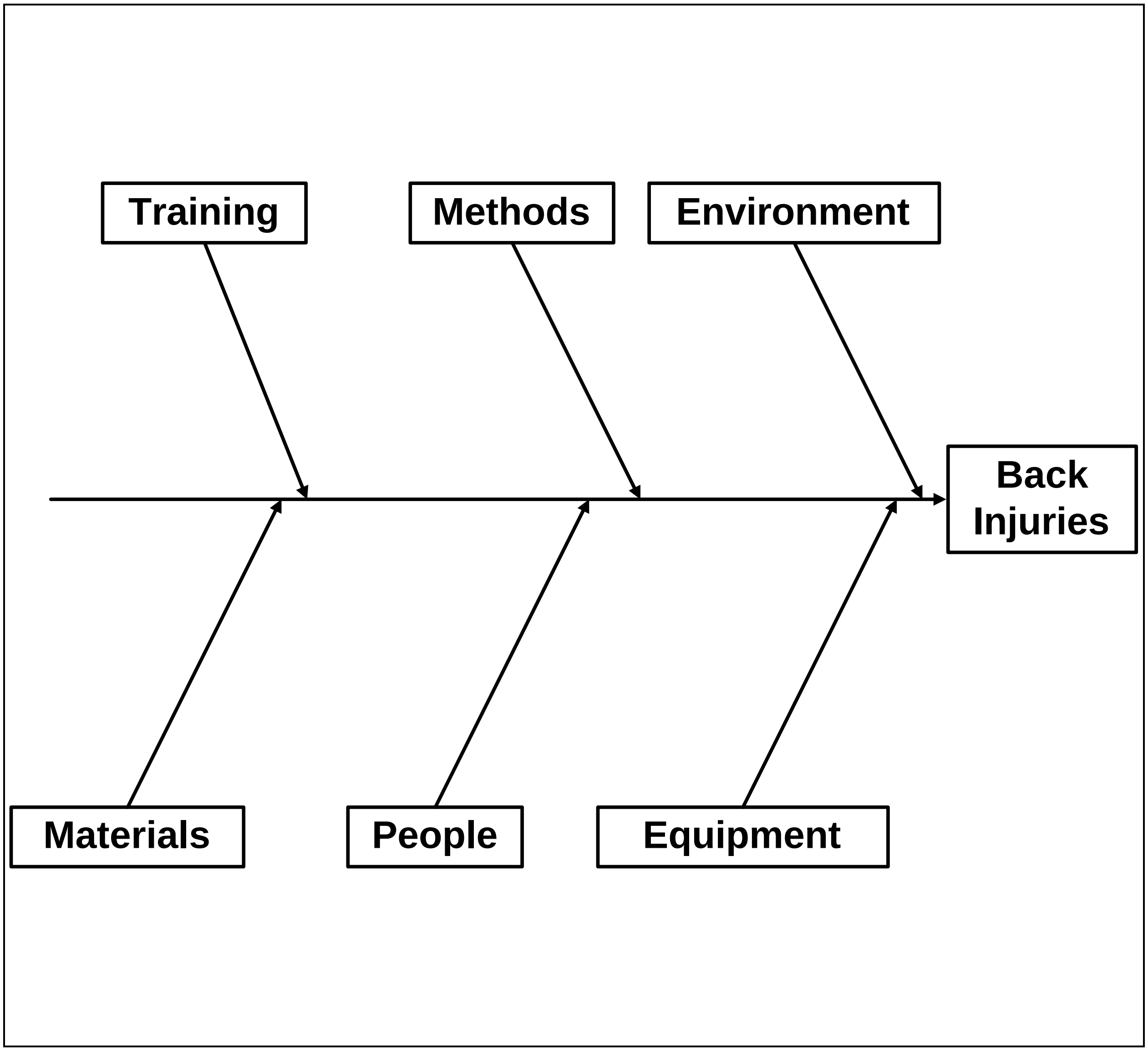


Figure 2.

Cause and Effect Diagram

Figure 3.

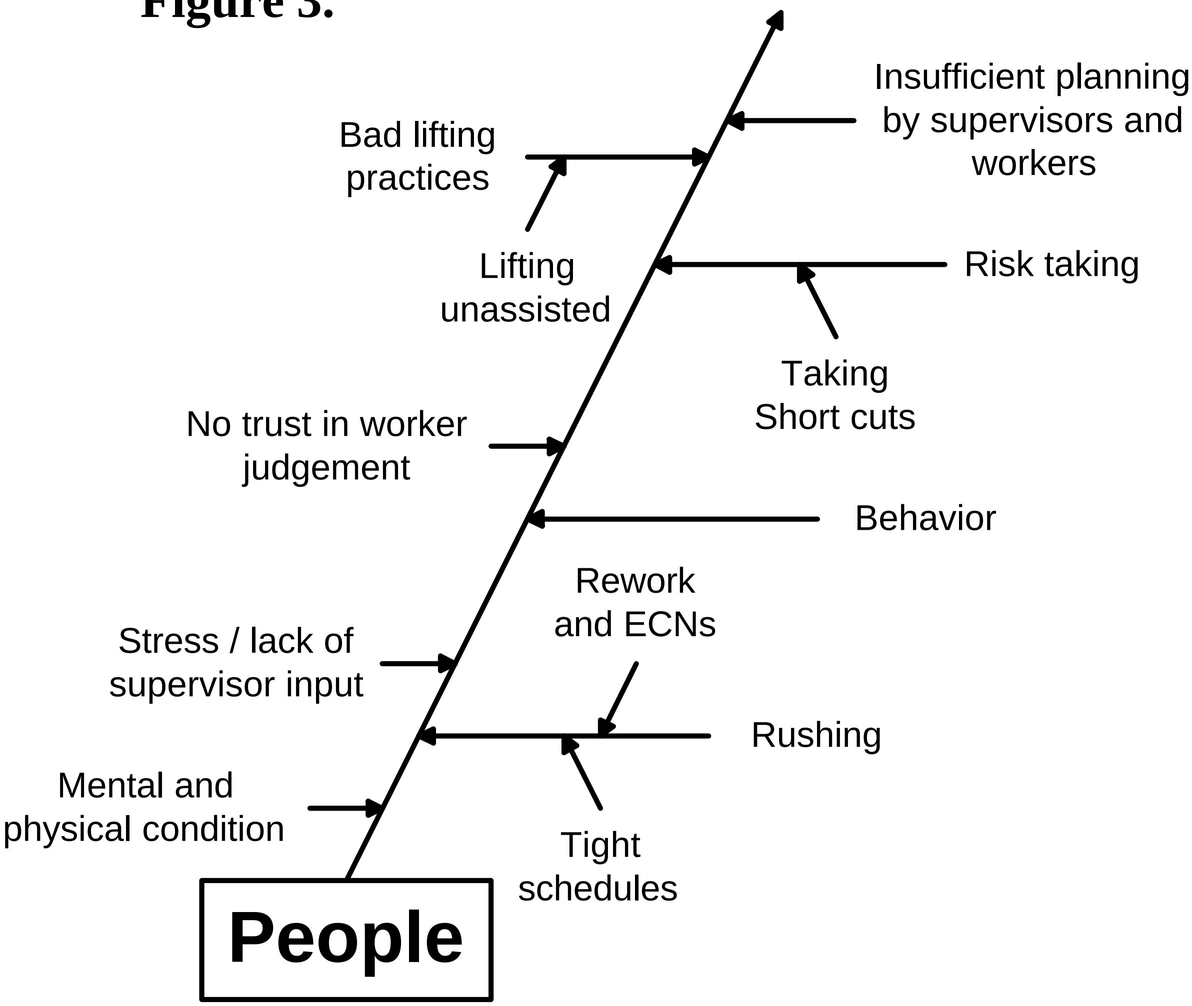

Insufficient planning by supervisors and workers
Bad lifting practices
Lifting unassisted
Risk taking
Taking Short cuts
No trust in worker judgement
Behavior
Rework and ECNs
Stress / lack of supervisor input
Rushing
Mental and physical condition
Tight schedules
People

Figure 4. SAMPLE OBSERVATION SHEET (DAILY)

Observer ________________________		**Date** _____________
Location ________________________		
	Safe	**Unsafe**
Bend knees and use legs		
Keep back straight		
Keep load close to body		
Lift slowly and smoothly		
Get help with heavy loads		
Use tools/equipment to lift		
Build a bridge *****		

******* Added to checklist after training in 12/97

Figure 5. CUMULATIVE OBSERVATION TOTALS

Lifting Methods	7/97 to 9/97 Percentage Safe Pre-Intervention	12/97 to 3/98 Percentage Safe Post-Intervention
Bend knees and use legs	44.00%	79.00%
Keep back straight	47.00%	69.00%
Keep load close to body	56.00%	70.00%
Lift slowly and smoothly	54.00%	76.00%
Get help with heavy loads	60.00%	71.00%
Use tools/equipment to lift	51.00%	73.00%
Build a bridge	***N/A***	84.00%
Cumulative Total	**51.00%**	**71.00%**

Figure 6. SAMPLE ANALYSIS WORKSHEET

Job Name ________ **JSA/JHA Number** __________

Employee Name ________ **Area/Supervisor** __________

Employee Title ________ **Last Analysis Date** __________

Analysis By ________ **Analysis Date** __________

Job Steps	Potential Hazards	Necessary Safety Procedures	Required Safety Equipment

DELIVERABLE F

ELECTRICAL DEPARTMENT

TABLE OF CONTENTS

APPENDIX

SUMMARY

The Electrical Department encompasses many areas of Nassco including "Onboard" (both new construction installation and ship repair), "On-Block" ground outfitting, small shop repair services, and Facilities Maintenance.

The Electrical Trade services many areas of the "yard", and work tasks can vary greatly from installing and repairing equipment to pulling yards (actual miles) of cable. Various tasks include layout, installation, cable pulls, hook up, repair, and testing of shipboard equipment.

In order to perform most levels of electrical work, physical requirements such as frequent lifting, carrying, pulling, pushing, standing, climbing ladders, overhead reaching, and manual dexterity are necessary while performing such functions in contorted positions. Many electricians are also certified to weld braces and mounting equipment.

In 1996, a stretching program was instituted in cable crew work areas. The injury rates declined (for a while) following implementation during the first six months of the year, then escalated during the last half of the year. There were seventy sprain and strain injuries during 1996. This amounted to an injury percentage of 127% among a total of fifty-five cable crew employees.

In 1997, the injury rate declined significantly to 3.6%, with fifty-five employees assigned to the cable crew. The current rate is 2.3%, with forty-two employees remaining on the cable crew.

Of the total injuries in the electrical department, nearly seventy-five percent originated within the cable crew. The task of pulling cable is an extremely labor intensive and time consuming process. The amount of manpower utilized to position the cable spools for installation, as well as feed and layout of cable runs, is approximately sixty percent of the pulling process, forty percent of which is dedicated to actual physical labor.

During October 1997, six injuries were reported for the cable crew alone, with no other injuries reported by the electrical department. There were two injuries on the SLNC 1 (Sealift New Construction) and three on SLNC 2 with one injury occurring in a shop area. Due to these alarming statistics, a process improvement team was established to study prevention measures to help reduce the number of injuries to cable crew employees.

PARTICIPANTS

Due to the number of escalating injuries on the cable crew and electrical department, Dave Langenhorst, Electrical Department Superintendent selected a Process Improvement Team to investigate solutions to reduce workers compensation costs. The team analyzed injury data and interviewed accident victims, supervisors and others to determine causes and contributing factors to sprain and strain injuries. The team reviewed production procedures, work instructions and tool usage relative to impact on sprain and strain injuries. Other NASSCO departments were consulted when necessary to assist the team in developing solutions. Existing policies, procedures, work instructions and tools were not to be changed without approval of the appropriate managers.

The charter for the Electrical Process Improvement Team was as follows: **To analyze the causes of sprain and strain injuries among electrical employees and to develop methods of prevention.**

The following team members consisted of **Production, Training, Safety and Human Resources:**

Name	**Position**	**Department**
Gale Withrow	Electrical Employee Advisor	Electrical
Freddie Hogan	Project Engineer	Human Resources
Mike Yavno	Safety Representative	Safety
Paul Iwane	Production Supervisor	Electrical (Cable Crew)
Ken Henkemeyer	Production Supervisor	Electrical (Cable Crew)
Pete Hall	Working Foreman	Electrical
Jim Ferguson	Industrial Hygienist	Safety
Matt Martin	Working Foreman	Electrical (Cable Crew)
Phyllis Belisle	Training/Dev Specialist	Training

BACKGROUND

During the first meetings, "PIT" team members reviewed and studied research material pertaining to the nature of sprain and strain injuries. The team was able to determine root causes of back injuries, identify factors (both internal and external) and aggravating conditions that contribute to sprain and strain injuries. Most injuries involve the following dynamics under sprain/strain: surge of effort, beyond range of motion, and biomechanics.

Factors associated with the workplace that were identified as external: cable pulling, lifting objects, tightening nuts/bolts, extended reaching, working in awkward positions and cramped spaces, prolonged effort, walking while carrying weighted and sometimes uneven loads.

Factors that were identified as internal: outside distractions, emotional problems, lack of sufficient rest, lack of training, unwillingness to share the load or effort, physical weakness, body size, pre-existing medical conditions, medication and sedentary lifestyle.

Team members learned from professional speakers and other training presentations that a difference exists in how sprain and strain injuries are classified. Sprains typically involve either the stretching of or the more serious "tearing" of the ligaments, which occur with pain and swelling. Strains usually involve either muscular or ligamentous injury which include symptoms of muscular tenderness and weakness.

As the research process continued, the team reviewed departmental data and analyzed safety statistics regarding monthly injury rates - the number of injuries per month as well as yearly totals. **(Figure 1. Pages 53-56)** The most common injuries were "back" injuries frequently occurring within the "cable crew".

In order for the team to determine the causes of these injuries, explore prevention measures, and make useful recommendations, NASSCO injury data (period from 1995 through December 1997) was thoroughly analyzed. This data was then graphed according to the type of injury, the location in which the injury occurred, and the body part injured. This helped the team to identify internal and external factors that contributed to back injuries.

Other conditions can contribute to sprain and strain injuries. The following (conditions) were discussed among team members: beyond range of motion, diminished range of motion with age, repetitive motion, inflammation of the tissues (including rare degenerative tissue disorders), and improper body biomechanics.

Team members learned that improper body biomechanics implies improper or poor body positioning or motion.

Another workplace issue was discussed: the relative "inaccessibility" of many work spaces, particularly "on board". By design, many of the workspaces on a ship (especially while under construction) create an environment where safety is always a major concern. Employees "on-board" often work in confined areas and aggravating positions, while performing tasks that involve sudden pulling or twisting, as well as repeated movement or impact. As a result, many experience the effects of overexertion during daily activities in the workplace.

Team members discovered that many retired or ex-military (Navy) personnel are routinely hired at NASSCO. It is assumed that this is because they likely have prior shipboard experience and possess certain knowledge of ships' "on board" systems. However, when company injury data was analyzed, team findings revealed that the "personnel factor" is another issue that raises other questions and concerns about present hiring practices.

A survey was taken and a number of employees from the electrical department were interviewed. The following questions were asked: How long out of military service? How many E-5 and above? How long in trade? Prior injuries? Any warning signs of overexertion? Engage in any stretching or warm-up exercises, either at or away from work? Some additional questions were asked about the type of tasks performed, about safety and about the workplace in general. During this time team members also learned that there is a difference between "stretching exercises" and "warm up".

DEFINITION OF TERMS

A. Biomechanics

Those who have taken a physics course learned that "mechanics" involves the analysis of action relative to the science of motion and force. Biomechanics involves the study of the mechanical operation of the human body. It is the science of motion and force in living organisms. The musculoskeletal system of the body provides the foundation data for the study of biomechanics. Understanding biomechanics is important in determining causes of injury. Internal mechanisms, which enable the body to move, provide important information to the study of injury prevention.

In biomechanics, the measurement of primary concern is force. This is especially true as force relates to loads and stresses on the body. Force is defined as that which can cause an acceleration of matter. In biomechanics, there are two categories of force that create motion of biological matter or , in everyday terms, movements like walking or lifting. These two categories are: (1) *load*--the external forces upon a structure or organism, and (2)*stresses*--the internal forces generated in the structure as a result of loading**. (Figure 11. Pages 113-114)**

In the human body, all movement is made possible by the application of load and stress to biological levers. With an awareness of joints, bones, and muscles, biomechanics provides safety professionals with an understanding of how the musculoskeletal levers of the body are designed to work. Knowing how the body is designed to naturally move, professionals can identify and eliminate the unnatural movements that can result in ergonomic problems. Evaluation activities such as monitoring frequency and duration of movement or examination of postures and positions can be initiated to determine the level of ergonomic risk. Internal and external forces should be a part of this evaluation. These activities are performed as part of a job or task analysis.

When twisting or other unnatural movements of these biological levers are observed during a task analysis, they should serve as warning signal. Unnatural physiological movements and postures will eventually result in ergonomic injury. Ease of work activity or biomechanical advantage is only possible when weight is held and moved using the best posture and body position. These best postures and movements are our natural physiological movements.

Sprains and Strains: A sprain is an injury to a ligament or a tendon. A strain is an injury to a muscle. All three-ligament, tendons, and muscles-aid in the movement of your joints. A sprain can be much worse, especially if it's a major ligament like the anterior cruciate ligament in the knee. Sprains are most commonly a result of a twisting injury or impact injury

Muscle strain: A muscle strain is the term for a moderate amount of damage to muscle fibers. Limited bleeding inside the muscle causes tenderness and swelling, which may be accompanied by painful spasms. Visible bruising may follow. More severe damage that involves a larger number of torn fibers is called a muscle tear.

Muscle tear: A torn muscle causes severe pain and swelling. Extensive bleeding may result in the formation of a blood clot, which a doctor may need to remove by needle aspiration or surgical drainage. Vigorous shoulder movements may tear the deltoid or pectoral muscle where it attaches to humerus for example.

Inflammation: Swelling of tissues due to irritation of tendon or tendon sheath caused by friction of tendon on bone or tendon sheath.

Overexertion: During daily activities, more stress is put on the tissues than they are capable of withstanding. This results in strains and sprains (tears in the muscle, tendon, ligament, and cartilage tissues).

Sudden pulling or twisting: Movements also put stress on the tissues. The stress may pull the tissue beyond its ability to stretch. Twisting may force the tissue in a direction it wasn't designed to move. These movements can result in strains and sprains (tears in the muscles and tendons/ligaments).

Repetitive motion: Tendons and ligaments rub against adjacent tissues. When this occurs without periods of rest or alternative movements, affected tissues will be irritated. Irritation results in inflammation (swelling) and pressure on adjacent nerves.

Rotation: A movement in which a body part turns on its longitudinal axis. The turning of the head is an example of rotation.

Supination: The turning of the forearm or wrist such that the hand rotates and the palms are facing upwards.

Pronation: The opposite of supination. The turning of the forearm or wrist such that the hand rotates and the palm is facing downwards.

B. Operational Categories of Movement

Operational Classification of movement refers to the task being performed by the operator at the time of the job observation. The following is a list of the terms used to represent the operational classification of movement.

Positioning: This classification involves moving an object and corresponding extremity from one position to another. An example of positioning would be reaching for a bolt stored in a bin at the right of an employee.

Continuous movement: A single movement involving muscle control to adjust or guide a machine or other piece of equipment. An example of continuous movement would be the steering of a forklift.

Manipulative movement: The handling or assembling of parts. These movement classifications are usually limited to hand or finger movement. An example of manipulative movement would be the assembly of component parts.

Repetitive movements: These are the same movements which recur over and over. Hammering or using screwdriver would be examples of repetitive movements.

Sequential movements: A series of separate movements that are joined together in a specific order to complete a given task. Reaching for a tool with the right hand, gasping a component in the left hand, moving the two hands toward one another, and adjusting the component using the tool are examples of sequential movements.

Static movements: Maintaining the position of a body member in order to hold something in place. Though movement may not be involved, the muscles are required to maintain the steady position of the object. Holding a board or plaster board in place on the ceiling of a room while screwing it into position is an example of static loading of muscle groups or static movements.

C. Historical Analysis of Low back pain

Low back pain is one of the most common ills of mankind. Four out of five people will experience low back pain sometime during their lifetime. After the common cold, problems with the lower back are the most frequent cause of lost work time in adults under the age of forty-five. Economic losses because of back pain have been estimated to total $16 billion annually.

Fatigue and strain are the most common causes of low back pain. About sixty percent are from overexertion. The lower back or "lumbar spine" is where most people experience pain. The lumbar spine supports seventy-five percent of your weight. While not a direct cause of low back pain, emotional problems or stress-related tensions can aggravate back pain. A person with low back pain who is emotionally upset or stressed will often be very tense. Tension can increase muscle spasms in the back. These spasms lead to more pain, which itself causes the muscles to "tighten" or become tense.

1. What causes low back pain?

A. <u>Mechanical problems</u>

Pain in the lower back often has one or more of the following causes: poor posture, poor physical fitness, poor work habits, lack of regular exercise, obesity, or poor sleeping habits such as sleeping on the stomach.

B. <u>Injury</u>

Injuries caused by lifting heavy objects, falling, motor vehicle accidents, and sports activities are common causes of low back pain. Lifting injuries are the most avoidable. Bending the knees while lifting objects can prevent many.

C. <u>Acquired conditions</u>

Low back pain as well as leg pain can be caused by spondylitis, a condition in which bone does not form completely in the lower spine, causing one vertebra to slip onto another. This condition affects as much as 2% to 3% of the population. Other conditions that occur during life such as arthritis and osteoporosis (porous bone) are frequent causes of low back pain in older age groups.

D. <u>Infection</u>

Infection involving the vertebrae or the connective tissues between them may occasionally cause severe low back pain. These infections are treated with antibiotics, and sometimes surgery. They can cause damage to the vertebrae that may

require a long recovery period.

2. **Other common causes of back pain**

a. **Over exertion** - Over-doing activities you normally don't do.

b. **Muscle Spasms** - Strong, painful contraction of the muscles.

c. **Overload injuries** - Lifting more weight than you should.

d. **Posture** - Poor posture can contribute to back pain.

e. **Lifestyle changes** - A decrease in activity level may contribute to back pain.

f. **Emotional stress** - Stress causes the muscles to contract.

g. **Pre-existing conditions** - Physical conditions such as Scoliosis, Spondylitis, Spinal Bifida, or Arthritis may cause back pain.

h. **Ruptured Disc** - The most common, serious cause of back pain.

D. Cable Pulling Process

1. Preparation

A. Cable runs are measured using route sheets, blue prints and the latest ECN's.

   1. Check for accuracy

   2. Location of equipment moved

   3. Change of cable types or deletion of cable

B. Cable order is sent to vendor where cables are cut and delivered to NASSCO on specific dates.

C. Scaffolding is installed and secured along completed cable run, prior to commencing installation.

D. Cable pulling machinery (chugger) is set up at logical pullout points

2. Installation Procedures

Cable is installed by Work Teams strategically located (approximately eight employees).

A. On the Deck (four employees).
   1. Turning cable reel (two employees)
   2. Laying cable uniformly on deck (two employees)

B. On Scaffolding (two employees)
   1. Lubricating cable (one employee)
   2. Following end of cable through wireway (one employee)

C. On Deck, at pull-out point (two employees)
   1. Chugger operator
   2. Laying cable uniformly on deck (one employee)

D. Once cable reaches destination location, excessive lengths are cut and information is reported to cable tracker.

Note: To insure that proper cable lengths are accurately placed near equipment locations, one employee is assigned to "map and measure" correct cable lengths at

equipment destinations.

E. Team Activities

Brainstorming

During the early team meetings, many ideas were presented and analyzed as possible injury prevention factors. Using the technique of "brainstorming", the team was able to identify a number of conditions and focus on key issues that became the source for a formal investigation. Many ideas and recommendations continued to surface throughout the investigations. In order to reach a viable solution to the "assigned" problem, the team used a "filtering process" to maximize time and effort. The team consulted with production supervisors (both salaried and hourly) because of their specialized knowledge working with a number of employees who had been injured on the job. Because the supervisors witnessed and often tried to prevent many of the accidents and injuries to these employees, their suggestions were carefully considered.

Because of the team's injury prevention investigation, it was agreed that the following suggestions should serve as a purposeful course of action:

- Warm - up vs. Stretching
- Backbrace (use of) - Positives vs. Negatives
- Back Injuries (possible causes)
  - Poor Posture
  - Improper Body Position
  - Overexertion
  - Job Assignment
  - Behavior
- System of Tracking and Transferring Employees (from one supervisor to another)
- Utilizing "People Soft" Program for Tracking (above) (NASSCO HRIS)
- Observation Program
- Employee Survey
  - Attitude (behavior)
  - Environment
  - Incorporate "Therapy Specialists" recommendations

As team members visited job sites "onboard" to evaluate the work environment, cable crew employees were observed in the cable pulling process. Team members observed that employees larger than the average size (in height and weight) were placed forward, or in front of the cable, to unreel, flake out, feed and guide large cable into a tray up into main wireway's. Smaller cable crew employees were placed further downline of the cable during the pulling process. Team members discovered that the larger cable pulleys were usually injured first and more frequently, especially when they were required to pull cable in tight or confined areas of the ship. The injuries frequently occurred in the machinery rooms, engine rooms and switchboard compartments.

Because of the type of ships that NASSCO is building, approximately forty-eight percent of all cable installation requires T-400 cable, with the remaining installation requiring T-300 cable and smaller. Fifty-five percent of T-400 cable is installed in engine room spaces, while forty -five percent is installed in the cargo and house areas. The process of installing smaller cable is not as labor intensive as the process of pulling large T-400 cable. In many cases only two employees are required to install small or "local cable", depending upon the location and the amount of obstructions. Upon further review and analysis of injury data, team members discovered that the frequent injuries to cable crew employees, who had large body frames, occurred as a result of pulling large T-400 cable while working in cramped and contorted positions inside engine rooms and tight spaces in cargo holds. T-400 cable weighs approximately six pounds per foot with a circumference of three inches and is difficult to grasp and pull. Attempting to overcome fatigue and reduce the stress of impacted areas of the body such as the hands, arms and shoulders, cable crew electricians are encouraged to take brief rest periods to "recuperate".

Assigning a larger than average size employee the task of pulling or handling T-400 cable while having to work in a contorted position inside a confined space or cramped area with previously installed equipment, is viewed by team members as an "accident waiting to happen". The inaccessibility of ladders and scaffolding raised additional concerns in regard to other safety hazards, such as slipping and falling. In recognizing these potential hazards, the process improvement team made additional suggestions in regard to shipboard design and fabrication. The team decided to document all concerns and relay them to the Engineering Department through Electrical Superintendent Dave Langenhorst.

Team member Ken Henkemeyer held a discussion with two of the local subcontractors currently with NASSCO to obtain information about injury rates in their organizations. Both Hopeman Bros. and PCI have consistently had low injury rates in comparison to NASSCO over the past few years.

The subcontractors provided the following information:

1. Commitment to Safety vs. Production. Safety is part of the "Operating Philosophy" of both companies.

2. Regular Safety Meetings

3. Use of Back Belts as well as Pre-Briefing on Jobs involving Lifting and / or Moving Equipment.

4. "Stop" (Anonymous) Observation Cycle Program (Hopeman Bros.)
   - (a) Focus on Trends (Daily)
   - (b) Active Correction vs. Accident System
   - (c) Immediate Attention/Response to Potential Accident Situations
   - (d) More Emphasis on Accountability vs. Written Warning

F. Warm-up vs. Stretching

Production Supervisors explained to team members that, although a stretching program had been instituted, the program is not mandatory for the employees. They also noted that there had been minor reduction in the number of injuries, especially in the "On-block" area. The program is available (or is required) with the consent of the production supervisor of each group designated to participate. The individual assigned to "lead" the employees performing stretching exercises must follow the guidelines and precautions stated in the outline of the program. There can be no exception to this requirement.

1. Distinction between Stretching and Exercise

Exercise is designed to warm up the muscles and tendons and to increase blood flow. It is also designed to strengthen muscles. While desirable, it is not the goal of this program to lead employees in this type of activity. The best form of warm up is to perform work activity itself. The employee must begin slowly and build up his or her level of activity as their body permits.

Stretching is designed to maintain or increase an individual's flexibility and range of motion. Why is this important? Because, a large number of musculoskeletal injuries occur when individuals exceed their level of flexibility and range of motion. Thus, anything that can be done to maintain good flexibility or improve limited flexibility is helpful in preventing damage to these tissues.

2. Words of Caution

Stretching is best done when the muscles, tendons, joints, etc. are warm and have good blood flow. These tissues are more pliable or elastic when warm. The individual may risk tearing or straining these tissues when they are cold and stiff. Some recommendations to overcome the coldness and stiffness prior to stretching: move around-get the blood flowing, move your arms, legs, and torso without challenging the limits of your range of motion.

It is not intended that this program result in vigorous movement of any type. It is important that individuals learn to "listen" to their bodies and to recognize when it is warning them against performing certain functions and when it is giving them permission to go ahead with an activity.

The body movements are to be gentle in nature and such that each

individual gently tests his or her limits of flexibility and range of motion with an easy stretch. After holding the easy stretch, test the body's willingness to go to a fraction of an inch further.

Only with the permission of their body should an individual extend the movements that bring on mild discomfort. This extended stretch is called the developmental stretch. Remember the adages of "mind over matter" and "no pain, no gain" do not apply to us when stretching.

Sensible stretching does not involve any "pumping" or "jerking" movement. We have all seen people do this, but those who engage in these types of movements while stretching are using poor techniques that can and probably will lead to injury.

G. Backbrace (Positives vs. Negatives)

Issues concerning the use of backbelts was hotly debated among PIT team Safety representatives. Their contention was that back "support" belts don't prevent back injuries. However, remaining team members learned that many of the local subcontractors (who were using back belts) had experienced an overall reduction in their injury rates, and adamantly insisted upon sponsoring a "pilot" program to test the belts. They could then find out what benefit, if any was to be derived from using them. The team unanimously voted to select two crews in the Electrical Department to participate in a back safety study, which included a pilot program to test the belts. Dayshift cable crew employees were selected to test the belts because it was more convenient for the dayshift production supervisor to monitor the employees using the belts and to provide a fair accurate evaluation.

In order to obtain fair, accurate data from the testing, the team used the following criteria: **Commitment, Identification, Availability, Training, Medical Surveillance and Ergonomic Evaluation.**

Commitment: A pro-active commitment to reducing back-related injuries is the most important element of a successful program. A Win/Win decision. This commitment must start at the top of the company and organization and must be transmitted to every employee.

Identification: Identify the kind of job that often contributes to lower back injury. Identify tasks where frequency, bulk and weight exceed NIOSH targets. Identify individuals, who have suffered a previous back injury, they are four times more likely to re-injure themselves than those who have not had a previous back problem.

Availability: Make backbelts available to those individuals who would like to use them. Allow individuals to choose between 2 or more backbelt models, so their personal needs are met, and their "buy-in to the program is present.

Training: Employees need to know a Back belt can lessen the risk of injury by reducing unwanted muscle contraction. By reducing unwanted muscle hypertonicity, a back belt can maintain the lower lordotic curve of the lower back, desirable in lifting and seated postures. They need to know a backbelt will not weaken muscles, because it doesn’t deny range of motion or do the work of the muscle groups. In addition, it won't help anyone do anything extraordinary.

Each belt should be labeled as such, to prevent misunderstandings. Sessions on safe lifting techniques, physical conditioning, and the benefits of good posture are all part of ongoing training.

Ergonomic Evaluation: Establish a task force, develop action plan, analyze work site and work practices, assess employee capabilities, define possible changes, prioritize actions, and measure results. The evaluation should involve the input of all employees.**(Figure 10. Page 107)**

Medical Surveillance: Individual physical capabilities should be determined to establish if they are able to perform specific tasks over the expected duration.

As indicated by research recently conducted, there is an apparent lack of consistent application regarding evaluation criteria. **(Figure 8. Cal-Osha Report dated 9/8/97 page 103).** Bias becomes quickly evident. We must evaluate information carefully, perhaps seeking assistance when attempting to understand data and conclusions. In a recent summary of positive and negative studies on back supports, the reviewer notes that he did not include many studies in his paper because they have no matched control group, no post-trial sample size, etc. Yet, in the clinical trials cited, virtually none of these criteria is met.

Apparently, there was no scrutiny of practical issues, such as the appropriateness of wide, stiff belts worn by workers while loading luggage in a forty-two inch fuselage of an airplane. The researcher in that study indicates 58% of the workers discontinued wearing the belt prior to the end of the project. We constantly hear this study cited as a case against back supports. Shouldn't the conclusion be that certain styles of belts are not appropriate in certain situations. Training should include a choice of belt to use. Isn't that true of hearing protectors, safety shoes, and respirators?

For example, hard hats can't really prevent many injuries by themselves. **A "Hard Hat Area"** program prevents tools and material from falling, makes head height obstacles avoidable, and prominently displays signs to alert potential danger and remind people to follow the rules. A **"Hard Hat"** alone does not prevent head injuries, as well as an implemented comprehensive program.

METHODOLOGY

A. Analysis of Injuries/Analysis of Charts

The following is actual information obtained from FROI report (First Report of Injury) data, based on actual dates of injuries over the past year in the Electrical Dept., which indicate that:

1. Number of injuries was high on the first and second days following a holiday.
2. A significant number of injuries occurred in the middle of the week on Wednesdays.
3. Number of injuries was lower on the day before a holiday.
4. Most injuries occurred among new hires in the department.
5. Repeat injuries were low - approximately one quarter of those injured was repeat/multiple injuries.

Possible Causes Noted:

1. Before a Holiday
   (a) General Job Duties - different (usually clean-up)
   (b) Mind set is different- getting ready for the holiday

2. Following a Holiday
   (a) Exhausted from holiday
   (b) Different mental attitude
   (c) Not focused on job
   (d) Possible injury at home on the weekend
   (e) Holiday activities were not relaxing

3. Wednesdays
   (a) More tired- middle of the week
   (b) Need to often "pick up the pace"-"Hump Day"

In order to put together a survey that would effectively get to the root causes of these injuries, the team compiled an additional list of known conditions of back strain and/or sprain. After compiling the list, the team grouped the conditions into the following categories: **Beyond Control Issues, Employee Controlled Actions/Activities, Management Controlled Issues, Mental Factors, Physical Factors (Body), training.**

Beyond Control Issues
- Age
- Body Size
- Posture

Employee Controlled Actions/Activities
- Attitude/Behavior
- Battle fatigue
- Conditioning/Exercise
- Improper clothing
- Lifestyle
- Outside Distractions
- Overall Fitness
- Second Shift Prior Activities
- Stress (mental)
- Tired
- Value System

Management Controlled Issues
- Changes in circumstances
- Environment
- Hiring practices
- Job assignment
- Lack of consistent approach to training and orientation
- No penalty for bad safety numbers
- Technology
- Trying to make a good impression

Mental Factors
- Attitude / Behavior
- Inside distractions
- Lifestyle
- Morale
- Past practices
- Responsibility/Accountability issues
- Stress (mental)

- Unfocused
- Physical Factors (Body)
  - Awkward position
  - Beyond range of motion
  - Bio-mechanical
  - Body changes
  - Extended reaching
  - Improper /Sudden body movement
  - Over exertion
  - Physical Condition
  - Prolonged effort without rest
  - Repetitive motion
  - Stress (physical)
  - Surge of effort
  - Tightness
  - Unequal forces
  - Weight distribution
- Training
  - Awareness
  - Don't know the Consequences
  - Inadequate or Lack of Training
  - Time in Trade

B. Questionnaire

After identifying additional conditions of back injuries, the team decided by weighted vote to formulate questions that matched the Six categories. The categories are: Beyond **Control Issues, Employee Controlled Actions/Activities, Management Controlled Issues, Mental Factors, Physical Factors (Body), Training.**

Next, the team decided which groups of employees and how many would be interviewed. The decision was made to interview five employees with records of multiple injuries. These employees would be the group to test the validity of the questionnaire. The team then drafted a questionnaire limited to fifteen questions. Interviews were not to exceed thirty minutes, so that interest would not be lost. If any changes were to be made before further interviewing, a vote would have to be taken. Team members decided that "open ended" type questions would be best to promote honesty and possibly obtain additional information that might be useful. The "team" concept of decision making and problem solving helped to bring issues to the surface, which hadn't been previously thought of, especially during the interview process.

The advantage of "open ended" questions is that they encourage employees to open and reveal their personal thoughts and issues to the interviewer that they may not otherwise talk about with their supervisors. This happened with most employees during the interview process.

Before the interviews were conducted, team members also took part in interviewing skill training to effectively gain information.

The following is a outline of the team training process:

1. Interview Techniques

a. Build Rapport

b. Introduce the Interview

b. Open-ended Questions

c. Probe

d. Allow for Silence

e. Seek Contrary Information

f. Control the Interview

g. Take Notes

2. Probing

A. Nudging Probe:

1. I see
2. Go on
3. then?

B. Clearinghouse Probe:

1. Have I missed anything you can think of?
2. What have I not asked that might be of importance?
3. Is there anything else you'd like to add?

C. Informational Probe:

1. Tell me about.....
2. What happened after....
3. How did you respond to...
4. Why do you feel that way?
5. I'm not sure I understand your point.

D. Reflective Probe:

1. Reflects answer in order to clarify and verify it
2. Was that net or gross income?
3. Then, you are going to support this proposal?
4. You mean________don't you?

E. Mirror or Summary Probe:

1. Confirm understanding and meaning
2. Summarizes a series of answers

F. Nonverbal Communication

1. Making direct eye contact
2. Avoiding eye contact
3. Shaking head
4. Yawning

5. Patting on the back
6 Scratching the head
7. Smiling
8. Biting the lip
9. Tapping feet
10. Folding arms
11. Raising eyebrows
12. Narrowing eyes
13. Flaring Nostrils
14. Wringing hands
15. Leaning forward
16. Slouching in seat
17. Sitting on the edge of seat
18. Hunching over
19. Having erect posture

G. Interview Format

1. Preparation
2. Rapport Building
3. Introduce the Interview
4. Body of the Interview
5. Inform
6. Answer Applicant's Questions
7. Close the Interview
8. Rate and Evaluate

I. Electrical Safety Questionnaire

1. How has training (in proper lifting, pulling, and material handling) by your supervisor or any other manager helped you perform your job or affected your work habits? ....
....

2. How do you know when you're involved in a potentially dangerous situation or work task? ....
....

3. Have you taken part in a stretching program? If yes, do you feel it was effective in preventing strains and sprains?...
....

4. Do you sometimes feel physically tired or have muscle or tendon stress because of continuous physical activity? ....
....

5. Do you pace yourself when you work and use your downtime to counter stretch?
....
....

6. Are you easily or often distracted on the job?..
....

7. Would you use a back belt if it were provided? Why or why not? ....
....

8. Do you feel comfortable telling co-workers from another trades when they are about to do something unsafe? If not, why? ....
....

9. How does it make you feel if a supervisor from another trade tells you when you are about to do something unsafe? ....
....

10. Do you believe that upper management is concerned with preventing injuries to employees or just in decreasing accident rate numbers?.......................................
....

11. Do you think all departments and trades share the same goals when it comes to safety? ....
....

12. Do you have any reluctance to report and injury? If so, explain. ....
....

13. What three things should NASSCO's Electrical Department employees do that could reduce back, muscle and tendon injuries? ....
....

14. How does personal responsibility play a role in preventing injuries? ....
....

15. If you had an opportunity to change the present safety culture at NASSCO would you become involved in the process?..
....

Additional interviewer's comments: ....
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Interviewer____ **Date**__________________

C. Interview Results

1. All 17 said "Safety Grams"
2. (Figure 2.page 57)
3. 13.....Yes / 4....No
4. 14.....Yes / 3....No
5. 11.....Yes / 6....No
6. 12.....No / 5....sometimes
7. 9......Yes / 8.....No
8. 11....Yes / 3.....No.......1....sometimes
9. 15....Positive Response, 2 Negative Response
10. 7...upper mgmt....3..No's only, 5..both true, 2..don't know
11. 9.....Yes, 7.....No, 1....don't know
12. 12...Yes, 5...No.
13. (Figure 2. page 58)
14. (Figure 2. page 59)
15. 17....Yes

D. Analysis of Questionnaire

After the first five employees were interviewed, the questionnaire was reviewed again to validate information and check for response accuracy. The first five employees were not only candid in their responses to the interview questions, but also were helpful in suggesting solutions to the problems. An additional twelve employees, who had been injured while working on the cable crew, were then interviewed. Individual employees were interviewed by two salaried team members, with an hourly employee observer present to help prevent possible intimidation as well as response bias.

This second group of interviewees was very helpful providing solutions and readily volunteering to assist team in any way possible. Using the "behavioral" approach to interviewing, team members discovered that most employees are very conscientious about safety on the job and possess a strong desire to participate in company decision making. Promoting the "team concept" whereby employees become directly involved in problem solving and injury prevention is nothing new to the industry. The Japanese were the first to use Doctor W. Edwards Deming's concept of this "team" approach to problem solving from the bottom up.

In order to solicit accurate, honest answers to the questions, it is very important to elicit employee "buy in" to be successful in the interviewing process. During the interviews, employees were reminded that their responses were recorded only to assist the injury prevention action team and not for future retribution or disciplinary action. These employees were encouraged to provide input for team recommendations and solutions. It is apparent that when employees are able to contribute to the decision making process with regard to safety, they tend to have a higher level of awareness about their safety and welfare on the job and be supportive of final recommendations.

The top responses from the employees off the questionnaires were: a stretching program or pre-work warm-up prior to cable pulling, the use of back belts, and training to enforce the message of back safety on a regular basis. Most of the employees had attended some form of back injury prevention training, but the message was not enforced on a daily basis. Examples under "not being enforced": immediate supervisors do not stress the importance of safety awareness enough, the five minute safety meetings emphasizing back injury prevention are too infrequent, first line supervision is not provided with an adequate "employee history" for individual transfer employees, information about prospective employees is poorly communicated, and production takes priority over safety.

Issues concerning "lifestyle change" often surfaced during the interviews. It was discovered that many "production" employees do not engage in regular "physical" activities following working hours that could help them remain "physically fit". It was noted that poor diet, lack of sleep or improper amount of rest, and the inability to fully recuperate before returning to a normal workday were some of the major causes of injuries. There is strong evidence to support the need for some type of after work wellness program. This could involve going to a gym, engaging in routine exercises at home, playing sports, or simply stretching to alleviate muscle tension and tightness. This is especially important for the retired military employee who may lead a more "sedentary lifestyle".

Smoking and overeating are also negative factors that increase the tendency for work related injuries. This is especially true with work that is entirely "physical" by nature, such as cable pulling. Smoking restricts blood flow and oxygen to the lungs, making it difficult to work for extended periods without resting. Cable crew employees take regular rest periods to compensate for fatigue, but when smoking is coupled with this high level of physical effort, the possibility is injury increases.

Maintaining a proper diet is paramount because nutrition is important to the effective working order of the human body. Some of the employees interviewed were aware of the role proper nutrition plays in preventing injuries. Overeating should be avoided. Obesity can cause physical limitations when pulling cable in restricted areas and where pulling requires the employee to work in contorted positions. Without proper nutrition, energy levels for the physical demands of the trade can not be properly met and the employee may further subject him or herself to back injuries.

The purpose of the survey (questionnaire) was not only to help the injury prevention action team understands why employees become injured, but also to learn how to change "behavior" that causes injures. Tools, equipment, and aspects of supervision can be corrected, but if the employee is not properly trained, or his/her behavior does not change, the injuries will continue to occur.

The "process approach" to injury prevention can be used in a program that is designed to promote behavioral change and reduce injuries by braking the "accident cycle". Some fundamentals include:

1. Employee involvement.

2. Operational definitions and measurement systems.

3. Positive charted verbal feedback.

4. Upstream performance measurements.

5. Proactive intervention

All employees share equal responsibility in the process. Behavior or "actions" which are "observable" are both manageable and measurable. The goal is to change "antecedent behavior" using a proactive approach - to "stop" before an accident happens. This is a purely "preemptive" approach. Applying this process includes:

1. Identifying critical safety related behaviors in operationally defined terms.

2. Training people to be observers to gather data - to observe safe and unsafe behaviors, then provide feedback.

3. A systematic ongoing and continuous improvement observation process in which observation data is used for problem solving and continuous improvement. Ultimately to create a culture where "safe behavior" is expected.

It is recognized that Management and Employee "buy-in" is important for successful implementation and requires addressing cultural barriers. Overcoming cultural barriers is essential for successful implementation.

TRAINING

A. Industrial Hygienist

James Ferguson, NASSCO's Industrial Hygienist gave the team a training session on soft tissue injuries. The training consisted of defining sprains and strains, and prevention measures needed to avoid injuries. A sprain is an injury to a ligament or a tendon. A strain is an injury to a muscle. All three-ligament, tendons, and muscles aid in the movement of your joints. A sprain can be much worse, especially if it's a major ligament like the anterior cruciate ligament in the knee. Sprains are most commonly a result of a twisting or impact injury.

He noted that: you should be in good shape, train properly, and always stretch before exercising, especially as you get older and your tissue gets tighter. It is also important to learn your body's limits and how much you can tolerate without injury. Take it slow, it is easy to get over-involved in any activity, whether it's weight lifting or gardening, and always be sure to use proper technique, knowing the right way to pick up heavy objects. He also noted causes of injury: **Overexertion during daily activities, Sudden pulling or twisting movements, Repeated movement or impact, Repetitive motion, Rare degenerate tissue disorders.**

He also discussed low back pain in great detail which include the following prevention measures:

1. Getting regular exercise.

2. Sit with knees higher than your hips

3. Practicing good posture

4. Push don't pull loads

5. Lifting only light loads.

6. Keep loads close to your body when lifting

7. Doing specific back exercises

8. Managing your stress

Some of the treatment methods discussed were:

1. Rest and relaxation will help relieve back pain.

2. Heat and massage can help relax muscles.

3. Cold can help reduce pain and swelling.

4. Anti-inflammatory such as ibuprofen or aspirin can help reduce inflammation.

5. If back pain persists, see your doctor. If you feel weakness, numbness, or pain in your legs, make an appointment to see your doctor.

B. Therapy Specialists

Therapy Specialists is a team of healthcare providers subcontracted by NASSCO to treat qualifying workers compensation injuries that require physical therapy. Jeannette Barrack, a physical therapist from this group, was invited to speak to the team about the causes of sprain and strain injuries, where they can most likely occur, and how to prevent them. She also discussed the common types of therapy her facility uses to treat these injuries and illustrated some useful techniques to prevent low back injuries.

Therapy Specialists' Theories on Causes noted:

1. Stressful, awkward positions
2. Improper body movement (example pulling &twisting)
3. Body mechanics
4. Body changes
5. Unequal forces on the Body
6. Unequal weight distribution
7. Lack of exercise, fitness and/or proper conditioning
8. Body size, makeup
9. Poor posture
10. Tightness in certain areas of the body
11. Performing strenuous activities before stretching or "warming up".
12. No specific stability program for improvement
13. Lack of change in daily activities
14. Lack of individual awareness and or training about injury
15. Prevention with respect to all of the above.

She explained that, while workers generally respond well to treatment after being injured on the job and do show they wish to "get well" so that they can "return to work", it is believed that workers often "set themselves up" for injuries. She also presented some helpful Techniques/Practices to prevent injuries such as: **Neutral Back-** Body Position, **Hinging-** For different movements (risks involved if not performed correctly), **Bracing** - Specific areas (legs, muscles, abdominal area).

Therapy Specialists' Treatment approach is as follows:

1. Localize the injured area and treat.
2. Stress on becoming fit as well as using the above techniques.
3. Retraining pressure so muscles can heal faster.
4. Encourage change (even 20% to reduce potential for injury)
5. Gentle stretching during healing process.

They also recommended using back belts, if worn properly. Before the back belt testing began, the team invited Therapy Specialists to perform "on site" training for the two groups of employees who were chosen to participate in the back belt "pilot" program. Employees were split into two groups of ten. Both groups were to receive training on how to properly use a back brace or "belt". However, only the first group of employees would actually wear the back belts while pulling cable. The second group would not wear back supports to pull cable.

The following is the outline used by Therapy Specialists to train the cable crew employees:

I. Back Education Training Program (Figure 3. Pages 60-67)

2. Information, general knowledge about the back, how the back works. (overhead visuals, see appendix)
    1. Anatomy of the back
        1. overview
        2. The Natural Curves
        3. Proper alignment of the spine
        4. The spine as a Bio-mechanical lever

    2. Physiological Aspects (Kinesiology)
        1. The mechanics of Good Posture
        2. Postural Balance- For efficient muscle performance
For smooth controlled motion
Crucial to movement

    3. Important Concepts
        1. Neutral Back
        2. Hinging
        3. Bracing

3. Contributing causes of Back Injury
    1. Sprains and Strains
        1. Lifting, Twisting, Bending Incorrectly
        2. Poor Posture
        3. Fatigue
        4. Accidents
        5. Sports Related Injuries
        6. Diet
        7. Generic Predisposition
        8. Heel Strike

4. Safe Lifting Techniques
    1. Why it is Important to Practice Correct Methods of Lifting.
    2. How to lift better, What works
    3. "The Lighter Side of Lifting" (Video Presentation)
        1. Prepare for the lift
        2. Keeping the Curves---Keeping the Natural Curves of the spine
        3. Maintain a safe Lifting Range- Keep the load Close or Center of Gravity over the Load.
        4. Use a Staggered Stance - Provides a Wider Base of support using legs.
        5. Shoulders over the hips- significantly less demanding of the lower back.

    4. Conditioning and Healthy Behaviors

    5. Warm up
        1. Reduces risk of injury
        2. Improves performance

    6. Stretching
        1. For Increased Flexibility
        2. Heightened Level of Endurance

    7. Benefits of Behavioral Change to Improve Overall Fitness
        1. Change in daily Activities
        2. Importance of Regular Exercise
        3. Importance of Maintaining a Healthy Diet.

    8. Final Summary - Closing Comments
        1. Stressed Outside exercise programs
        2. "When you bend over to pick up something light, and your back goes out, it's just a culmination of all the improper techniques prior to this injury".

C. Fisher Safety Co. E.L.A.T.E Program

Fisher Safety Co. was contacted to provide back belts for the pilot program. Fisher had been contacted on a prior occasion to provide samples of new back belts that contained air bladders. These new belts, once filled with air, would seat firmly in the contour of the lower back providing comfort and ease to the wearer. The team decided to test these new belts and work closely with the manufacturer in monitoring the effectiveness of the belts. Design changes would be considered, if necessary, to meet production requirements. One major concern with the test model was whether the material was sufficiently damage resistant to withstand the rigors of daily wear while pulling cable in and around machinery.

Pam Tappan from Fisher Safety Co. took the preliminary feedback to the manufactures (Safeguard Technologies), and they produced a belt that complied with the standards above. **(Figure 4.page 68)** These belts were produced with a more durable nylon fabric, including the necessary Fire retardant material. The belts included optional leather fasteners. The team decided that the test and trial period should last for three months, in order to obtain accurate and unbiased data. During this period, the team reviewed and modified the New **E.L.A.T.E.** back injury prevention program. The **E.L.A.T.E** program is designed to work in conjunction with the Air Belt. Pam provided data to show that this program has been very successful in other companies. **The E.L.A.T.E. Program stands for Ergonomics, Lifting, Anatomy, Training, and Education.**

The **E.L.A.T.E** training program covered the following topics: **(Figure 5.pages 69-89)**

1. The financial impact of back injury.

2. Contributing factors.

3. Ergonomic intervention.

4. Anatomy of your back.

5. Training for Safeguard's back supports.

6. Lifting and exercise techniques.

"E.L.A.T.E." became the main training resource for the Electrical Department Injury Prevention Action Team (E.D.I.P.A.T.) Back Belt Program. Although, the training package did require some tailoring to meet specific training needs of the cable crew members participating in the pilot program, team members agreed that only specific modules needed to be "customized" in order to meet (planned objectives) of the program. All twenty-cable pullers in the pilot program received special training given by Jeannette Barrack from Therapy Specialists. The two-hour training presentation included back education training, safe-lifting techniques, and recommended exercises from lecture materials, overhead visuals, and video presentations.

D. Video Presentation: "On the Road, The Lighter Side of Lifting."

Prior to testing the back belts, the team reviewed several videos of safe lifting practices. In the video presentation of "On the Road, The Lighter Side of Lifting," some of the most effective techniques for safe lifting were demonstrated. Similar methods that protect the back by limiting and distributing stress and exertion were also demonstrated.

The video presentation became the final viewing requirement for the training program. Both Electrical and Steel Erection PIT Teams incorporated the safe lifting methods (demonstrated in the video) into their safety improvement training programs. This video provides a common sense approach to lifting that encourages employees to think about lifting practices on a regular basis.

The information and techniques on this video is as follows: **(Figure 6.pages 90-100)**

1. **Show various types of lifting activities and how approach can alter strength, back stress, and efficiency.**
2. **Motivates workers to think before they lift any object, whether heavy or light.**
3. **Stresses the need for staying attuned to body position and work environment as a way of protecting the back.**
4. **Gives you the chance to explain your policies on lifting and to discuss use of back supports, equipment, or other assistance you offer.**
5. **Can be used for training new employees and for refresher training.**
6. **Explains a better way to lift that stresses weight distribution, stance, and warming up and relaxing.**

ANALYSIS OF TESTING

A. Test Group

During the period, employees were closely monitored by their badge number and when transferred - from one supervisor to another. Upon completion of the program, the employees were given questionnaires and surveyed again in order for the team to solicit feedback about whether the back belt should be required for the whole department. After three month of testing, no injuries were incurred among cable crew employees. Those who completed the training but did not wear the belts also remained injury free during this test period.

Though there was not enough evidence to either prove or disprove that the back belt (supports) actually "prevented" back injuries, both test groups believed that the belts could be effective in a more "comprehensive" safety program. From this feedback, and the results of the test program, team members concluded that "education" is the key to success of any injury prevention program. A well-informed employee, who is properly trained to use effective prevention techniques, can significantly minimize the risk of being injured.

There seems to be an increase in the number of workers who rely on back support belts to prevent lower back injuries while lifting. However, after carefully reviewing scientific literature, company surveys and other studies, the team found insufficient data to conclude that these "support" belts actually minimized the risk of back injury. Moreover, because workers think they're protected, they may attempt to lift even more when using these belts, subjecting them to even greater risk. Workers should be taught to use the stomach (rather than back) muscles when lifting.

In order to accurately weigh the benefits as well as possible disadvantages of wearing back belts, a more comprehensive study is needed. Because of design flaws, or the failure to correctly identify a special or "unique" problem in the workplace, some studies result in limited findings. Perhaps this is why there is not enough evidence to either support or refute the effectiveness of back belts in reducing injuries. Many of the earlier studies that were conducted did not evaluate the most common type of industrial back belts that are widely used today in production areas. If employers (and workers) are currently relying on back belts as personal protective equipment to prevent back injuries, they should be aware that there is a lack of scientific evidence supporting their use.

Rather than relying solely on back belts, the team recommends that employers and workers minimize their risk of back injury by developing and implementing a comprehensive ergonomic and safety training program. A program of this nature would focus on prevention and include:

1. **Assessment of all work activities to ensure that task can be accomplished without exceeding the physical capabilities of the worker.**
2. **Incorporate on-going, comprehensive employee training on proper lifting mechanics and techniques.**
3. **Provide a surveillance program to identify potential work-related musculoskeletal problems.**
4. **Include a medical management program.**

B. Cable Puller (Equipment)

Although the team had many ideas about how to reduce lower back injuries, cable pulling was still a major concern. Large T-400 cable was still being pulled in the traditional way by numerous cable crew electricians, rotating positions on different sections of the cable, often straining, pushing and pulling in the process. This method is considered ancient in comparison to most modern methods of cable installation. In shipbuilding, however this method is standard for main cable installation in the construction of large seagoing vessels and universal in most shipyards. T-400 cable, with the exception of the stainless steel braided cable, poses the most concern in cable installation, mainly because of its size and weight. The danger with stainless steel braided cable is that when the steel braid around the cable is torn or ripped, the thin, exposed fibers cause hand injuries, such as punctures and open wounds.

"There has got to be a better way", was frequently expressed during weekly team meetings. Fortunately, there were other resources available to help team members find better solutions. One of the benefits of recently improved shipyard communication is that information is often shared among various trades throughout the shipyard. A department in one organization may be able to provide a solution to a persistent problem existing within another organization.

During a technology exchange trip to Bath Iron Works in Bath, Maine, Fred Hogan, NSRP Project Engineer and advisor for "EDIPAT", spoke with Karl Siegfried, BIW's company ergonomist about cable pulling. Karl explained that, some years ago, Electric Boat Company had been working on a cable pulling equipment, but had to discontinue the project. Upon further investigation, Fred found that Electric Boat Company previously had been working on such a project. Fred then spoke with the SP-5 Panel Chairman, Chuck Rupy, about this conversation with Karl Siegfried about the cable pulling equipment project. He referred Fred to Greenlee Textron Corp. in Illinois. Fred contacted this company, then met with Greenlee's area representative, Steve Norris.

Fred met with Steve during one of his trips to NASSCO and discovered that Greenlee Textron Corporation did manufacture cable-pulling machinery. The Company was mainly in the business of selling equipment to the utility industry and was not directly involved with any shipyards. He toured NASSCO facility and spoke with Gale Withrow, Electrical PIT Team Leader, about the type of equipment that could possibly be used to pull T-400 cable. He stated that his company had a new type of cable puller on the market that could pull up to 8,000 lbs., **(Figure 7.pages 101-102) and** thought that this machine would be applicable for use on board ships.

He referred Fred and Gale to a local distributor that already had one of these machines in stock. Fred contacted the distributor and one of their sale representatives offered to bring the machine into the shipyard for a demonstration.

Following a successful demonstration by the vendor, NASSCO purchased one of the machines with other optional parts to assist with the pulling process. The potential of this machine, in terms of use and capability, prompted the electrical department to reevaluate and examine the cable pulling process again. The department discovered that T-400 cable could be pulled with ease and that the new machine could pull two lengths of cable simultaneously, thereby eliminating four electricians (stationed on the deck) from the cable pulling process on straight cable runs. Other important features of this machine include durability and mobility. Cable can be pulled from many different angles; upward and downward pulling requires only slight adjustments and optional parts to complete separate processes.

1. The Versi-Boom Plus System can reach into a manhole, yet allow the operator to run the puller from above.
2. The Versi-Boom System gives you the ability to pull out up to 20' of extra cable.
3. The slip-in coupling slips into the conduit or over the conduit. There are sizes ranging from 2-1/2" to 5". Also available are screw-on couplings in sizes ranging from 2-1/2" to 4" for pulling overhead.
4. Capstan is made of steel, which gives the capstan longer life.
5. The lifting eye is for use in moving the unit easily at the construction site.
6. Modular mounting with quick pins. The two-pin system locks the puller in place quickly and easily. Using the pins the boom can be locked into numerous positions, creating different pulling angles.
7. Permanent magnet motor (20 amp @120 volts.) This motor can operate on the job site at lower voltages.
8. Direct gear drive. The Ultra Tugger only weights 86 lbs. It's smaller, lighter and more compact.
9. Right angle sheave allows the operator to stand to the side of the puller and out of the line of tension when pulling.

This machine is versatile with the ability to pull up to 8,000 lbs. utilizing fewer splices to pull longer distances. The machine can be set up quickly, utilizing pins and attachments to mount the puller to conduit, concrete floors or mobile boom to meet all pulling needs.

It should be noted that this machine requires some modifications for shipboard use. Additional welding along with necessary design changes to the base and motor to increase durability is required for marine processes.

RECOMMENDATIONS

During the past year, a number of PIT teams, representing Steel, Electrical, and Blast & Paint trades, has made several recommendations for improving safety with a strong emphasis on injury prevention. These recommendations were the natural outcome of various findings, along with the successful intervention, development, and implementation of an effective prevention program. Team members also discovered that a "proactive approach" to injury prevention seems to work best. Rising injury statistics and increased injury, rates have been costly to many companies in terms of lost time and money. This has sparked the need for special programs in which participants are not only tasked to study causes, but to determine the types of behavior that "drive" these statistics. During the process of analyzing causes, PIT team members discovered that many of these "statistics" could have been significantly reduced or eliminated by changing "antecedent" behavior.

Although the various teams were successful in their efforts to reduce injuries, cut costs, and improve the quality of life for their fellow workers and supervisors, an extensive amount of time and effort were required to finalize the conclusions of this report. The process of researching and gathering information included many activities: interacting with a number of vendors, physicians, and safety professionals; spending several hours at a number of work sites; interviewing and interacting with numerous trade representatives, in order to acquire accurate information about specific trades, and to gain adequate knowledge and understanding of different trade processes. Most of the team met once a week, beginning in March of 1997. (The Blast & Paint Process Improvement Team began meeting six months earlier in September of 1996). An average meeting was scheduled for approximately one to two hours, but actual times relegated to field activities and research averaged about three to five hours per week.

This report is not intended to serve as a guide, but rather as a model - with recommended practices and procedures. Other considerations, with respect to company interests are also important, such as financial investment. Financial resources along with dedicated and committed personnel can help to achieve quantifiable results. While resources are necessary to implement the recommended procedures and practices, "commitment" (from the head of the organization to the lowest worker on the deck plates) is essential to the success of any program. A sense of enthusiasm, generated from upper management, is needed to capture and maintain the interest of all employees.

Certain company issues must also be resolved in order for a program to be successful. One issue that continues to be of concern among PIT team members

is "Production versus Safety". Production decisions should not override safety concerns. Production versus Safety should not be an issue of priority. A healthy, safe employee will increase production outputs. There may be some exceptions, but team members found that most employees are just as conscientious about production as they are about safety. As team members have often stated, "we believe that each employee has the right to return home (from the workplace) to family and loved ones injury free".

The modern industrial workplace is considered much safer today than during the early 1900's, as the quality of life has greatly improved in today's industrial work environment. However, the safety and welfare of company employees, whether in a manufacturing operation or otherwise, should not be compromised for production.

The following are practices and procedures recommended by the different teams to reduce worker's compensation costs:

A. Pre-Employment Testing

Applicant Screening should include more thorough pre-employment physical testing for overall fitness. In accordance with the American Disability Act, the following requirements should be met:

1. An offer of employment should be conditioned on passing a post-offer physical examination.

2. The examination should test for essential job related abilities only.

3. The examination should be required of all persons conditionally offered employment for the particular job or position.

In addition to the "essential functions" component necessary to make hiring recommendations in accordance with ADA, a comprehensive battery of additional medical and functional performance tests should be performed on each employee to establish baseline capabilities. This also facilitates detection of existing impairments and other medical and physical conditions. (Note: This medical and functional data cannot be used to withdraw an offer of employment tendered an employee.)

Following completion of the test, results would then be entered into a pre-employment test database, thereby providing a profile on each individual employee according to the physical demand levels of each specific job. The reports generated would also establish the baseline medical and functional

capabilities of the employee for comparison to future, post-injury data. During the pre-screening process, compare applicant's backgrounds to work applied for and look for best match or fit. Evaluate the applicant's skills and experience. Implement "behavioral based"interviewing to tie questions to previous experience. Both production and human resources should be present during formal interviews.

Once applicants are hired, only those who are physically able to perform continuous heavy lifting should be assigned to pull heavy cable on a routine or continuous basis. Specifically, this is to avoid placing or assigning new hires as well as long term employees, who are not able or capable, to areas where performing continuous heavy lifting is a requirement.

The following are various types of pre-employment testing used in manufacturing industries permissible during pre-offer of employment screening (Emphasis on production in Shipbuilding).

a. General aptitude assessment or "Scored Tests" include literacy and mechanical reasoning testing.

b. Work samples - skills testing (basic and advanced levels) are trade specific. Widely used, job samples are probably the most valid and efficient personnel selection tool.

c. Psychological profile (this type of testing can take various forms). Personality testing generally involves analyzing applicant responses from which HR personnel can determine job related personality traits and characteristics that are most likely to surface in the workplace.

d. Integrity testing (where behavioral indicators are derived from applicant responses), is used to determine an applicant's overall tendency to engage in counter-productive behavior.

e. Formal interview

Upon conditional, offer of employment:

a. Drug screening - A requirement for companies representing industries with government contracts. In addition, where serious safety risks exist.

b. Physical testing - usually a comprehensive "physical" but often includes physical abilities tests.

B. Training and Fitness

1. Training

There is a need for more specialized training in injury prevention for leadmen, working foreman and production supervisors. Increased training and safety awareness must start at the supervisory level. Production supervision must enforce the message of safety and injury prevention in the work environment. Subjects that can be reviewed include:

A. Training films on accident prevention as required viewing.

B. "Effective communication" classes for leaders (possible certificate series). Purpose: To help supervisors develop effective communication skills, to ensure communication of the message "safety first".

C. How to manage behavioral change. Appropriate action supervisors should take to get the desired responses they expect.

D. Using employee advisors appropriately in getting employees to change their behavior.

E. How to approach an employee from another trade when there is a safety issue. How to break down barriers.

F. Testing of supervisors and employees after the conclusion of safety classes to see if they really understood the information.

G. Emphasis on safety vs. scheduling. Often appears that problems are overlooked when scheduling is priority over safety.

H. How to get the whole crew motivated and encouraged about safety.

I. How to detect employee fatigue, possible drug or alcohol

problem and how to take appropriate action.

J. **How to inspect articles of clothing, portable tools, work area, for unsafe conditions.**

C. **Stretching / Exercise (During and After Work)**

When employees arrive for work in the morning (or evening), they likely have just started their daily routine a few hours before and therefore haven't really "warmed up" prior to work activities. It is important for employees, who are about to perform heavy, labor intensive work activities, to engage in some pre-work stretching exercises. This can decrease the potential for injuries, especially lower back injuries. Employees need to be properly trained to perform stretching exercises correctly, and to know that when they are warmed up, they are more prepared to perform strenuous activities, such as pulling heavy cable. For cable crew employees, it may even reduce the stress associated with having to perform their tasks in physically contorted positions while working in confined spaces on board.

For employees who want to increase their resistance to disabling injuries, post work stretching and exercise can be beneficial. Professional athletes train and condition their bodies to withstand a tremendous amount of tension and stress. This type of conditioning can also be beneficial to employees who routinely engage in labor intensive work related physical activities. Employees cannot be forced to engage in post work exercises, but can be encouraged to make the effort to do so.

Many companies in the United States are emphasizing the value of exercise and fitness. Many have highly structured wellness programs that include diet, exercise, smoking cessation, and daycare programs to accommodate single and married employees. The availability of such programs has

contributed to increasing employee morale as well as reducing injury costs to companies. When surveyed, the Electrical Department employees at NASSCO all said that they would participate in an after work exercise program if one was available. It was surprising to team members that most of these employees believed they would feel "energetic" and actually want to exercise after an eight hour work day of pulling and lifting heavy cable.

D. Job Rotation

Supervisors should be encouraged to rotate employees pulling large, heavy T-400 cable periodically. Frequent rotation of employees to other assigned work areas is highly recommended, especially since this task involves a routine of continuous heavy lifting. Crew members can be rotated frequently (hourly, daily, weekly) or from time to time (monthly) so that no employee is continually pulling the larger/heavier cable.

The following is a suggested format for rotating cable crew employees pulling T-300 or larger cable:

A. Large cable installation (Daily)

1. **Rotate workers on the "feed" every two hours because of exertion necessary to lift cable into overhead wireways.**

2. **Rotate individuals working in the wireways or at the end of cable pullout every four hours.**

3. **Remind crew members that if any worker is feeling fatigued, inform the supervisor. It may be necessary to assign the individual a different task.**

E. Back Belts

Information from various studies (and companies) concerning the use of back belts, for the most part, are inconclusive. The team recommends the use of back belts as a secondary precaution against lower back injuries. Redesigning the work place and making it easier for employees to perform their assignments, however, should be a main priority. Many companies do not believe that training is worthwhile, but, before coming to that conclusion, they need to consider what types of training programs could be beneficial to their employees. Employees participating in a back belt program need to understand that back belts are not a "cure-all" for back problems, but can serve as an additional prevention measure-reminding them to lift safely.

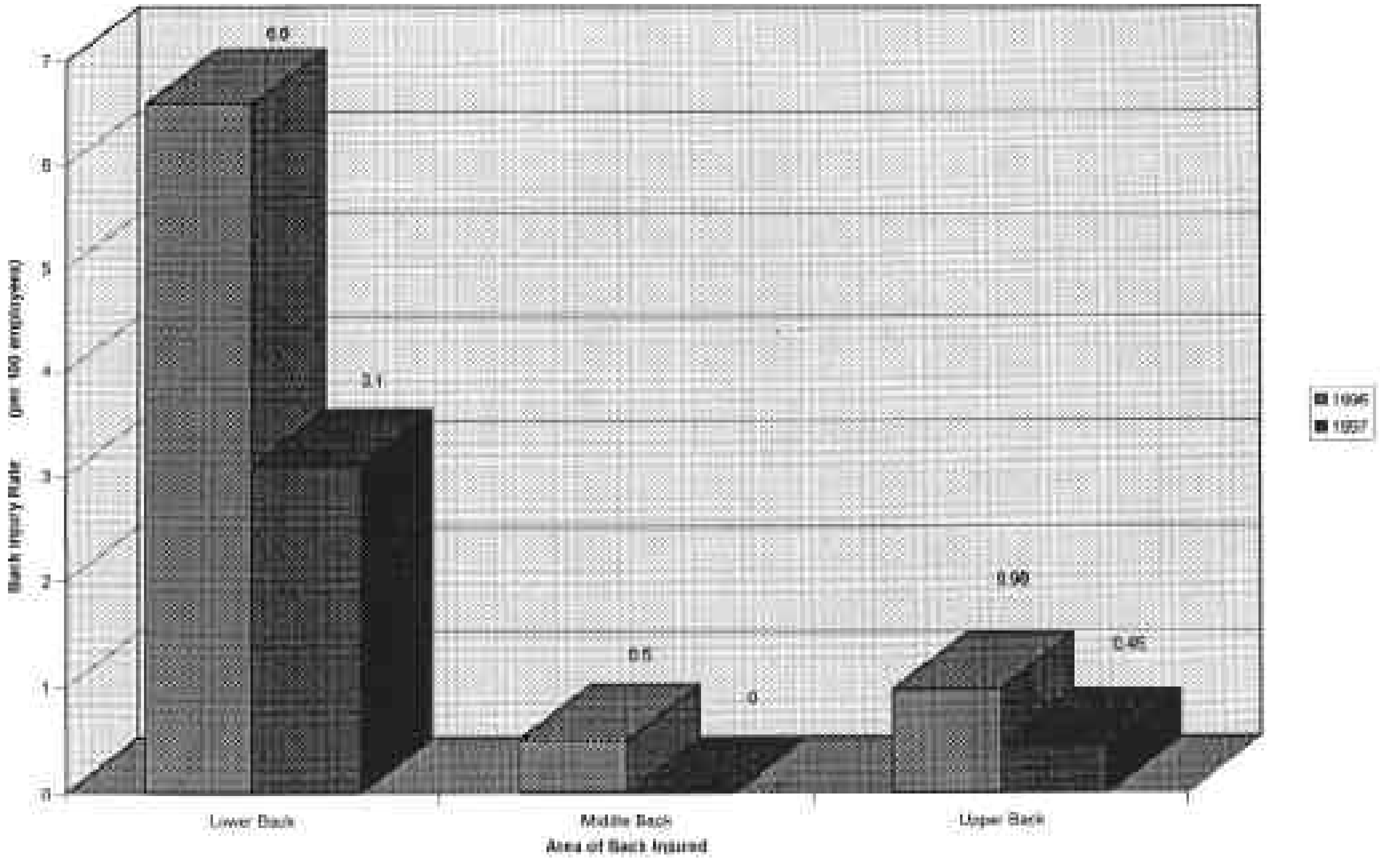
For a mandatory back belt program to be successful will depend on the type of back belts a company chooses to purchase for its employees. The air type back belts were well received by the electrical cable crew employees at NASSCO. They explained that these belts seemed to work well for them in terms of wear, protection, style, comfort and personal choice.

Although it was not mandatory for all cable crew employees to wear these belts, they were available to employees who wanted to use them. This seemed to be a positive approach. It is important to remember that, when selecting back belts, or any other type of personal protective equipment, "employee buy-in" is very important. It is important for the successful implementation of any injury prevention program.

APPENDIX

Figure 1.

1996 & 1997 Electrical Department Back Injuries



3/96 - 12/96

3/97 - 11/97

Figure 1.

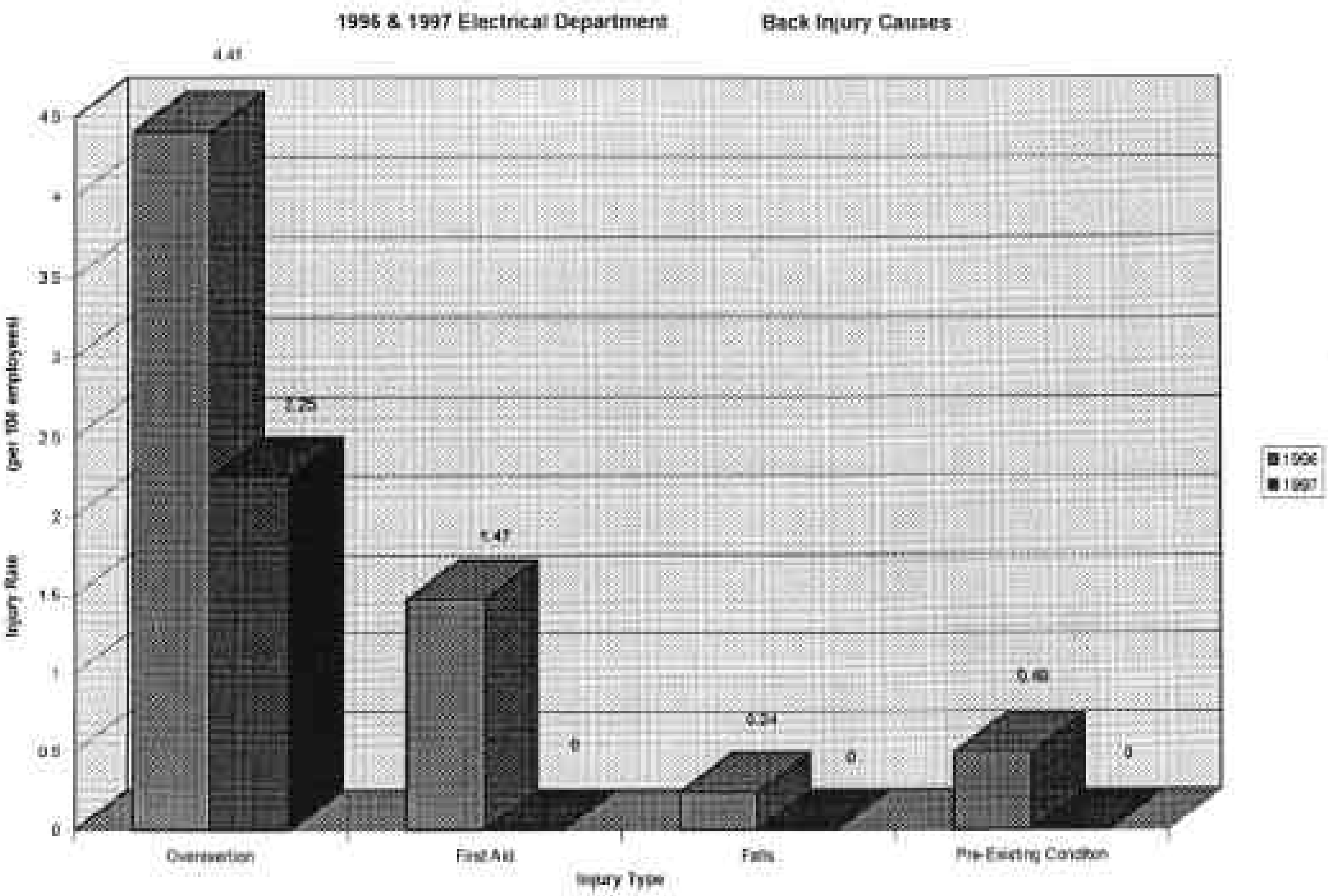

1996 & 1997 Electrical Department Back Injury Causes
Injury Rate (per 100 employees)
Injury Type
Overexertion
First Aid
Falls
Pre-Existing Condition
1996
1997
4.41
2.25
1.47
0
0.24
0
0
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5

Figure 1.

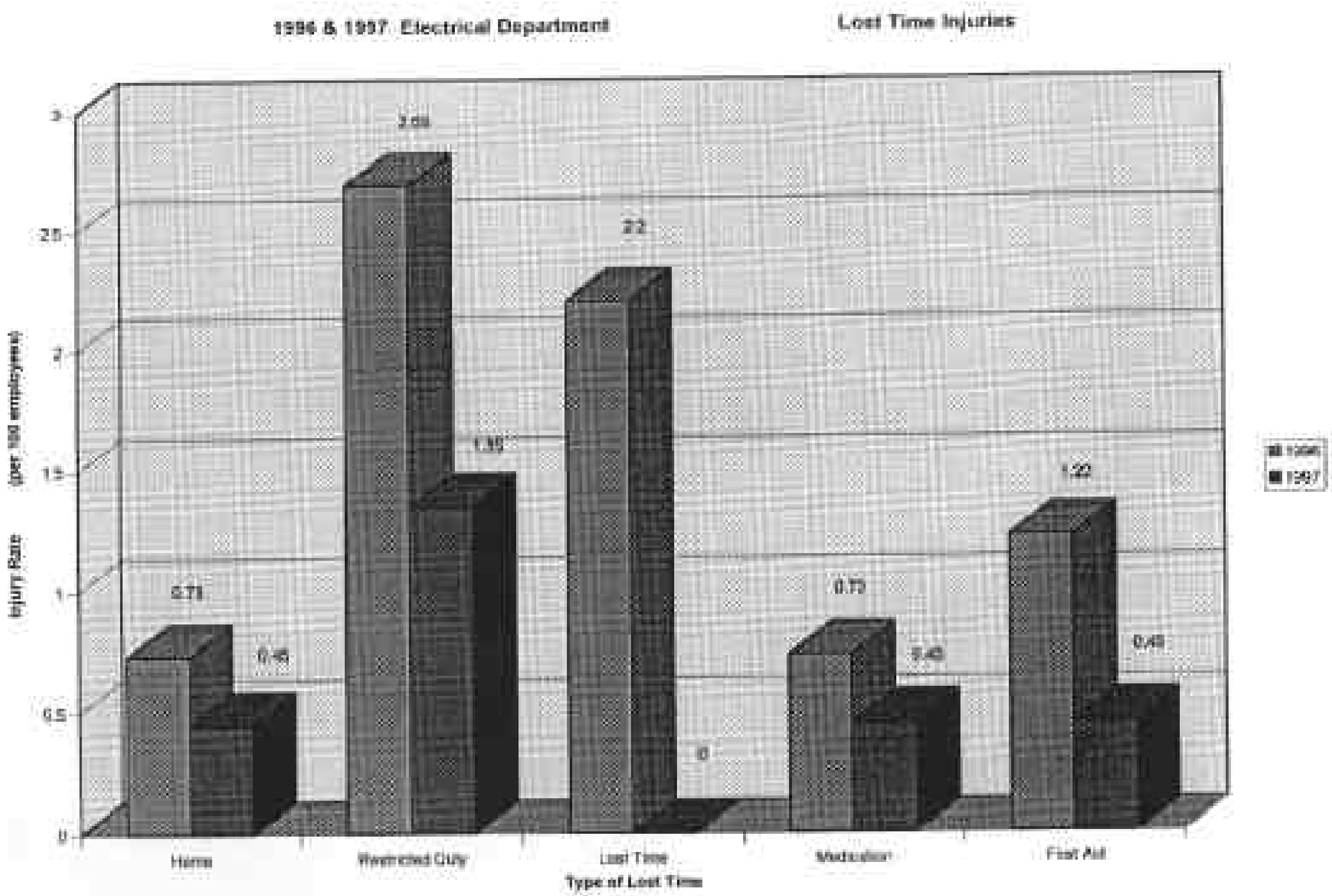
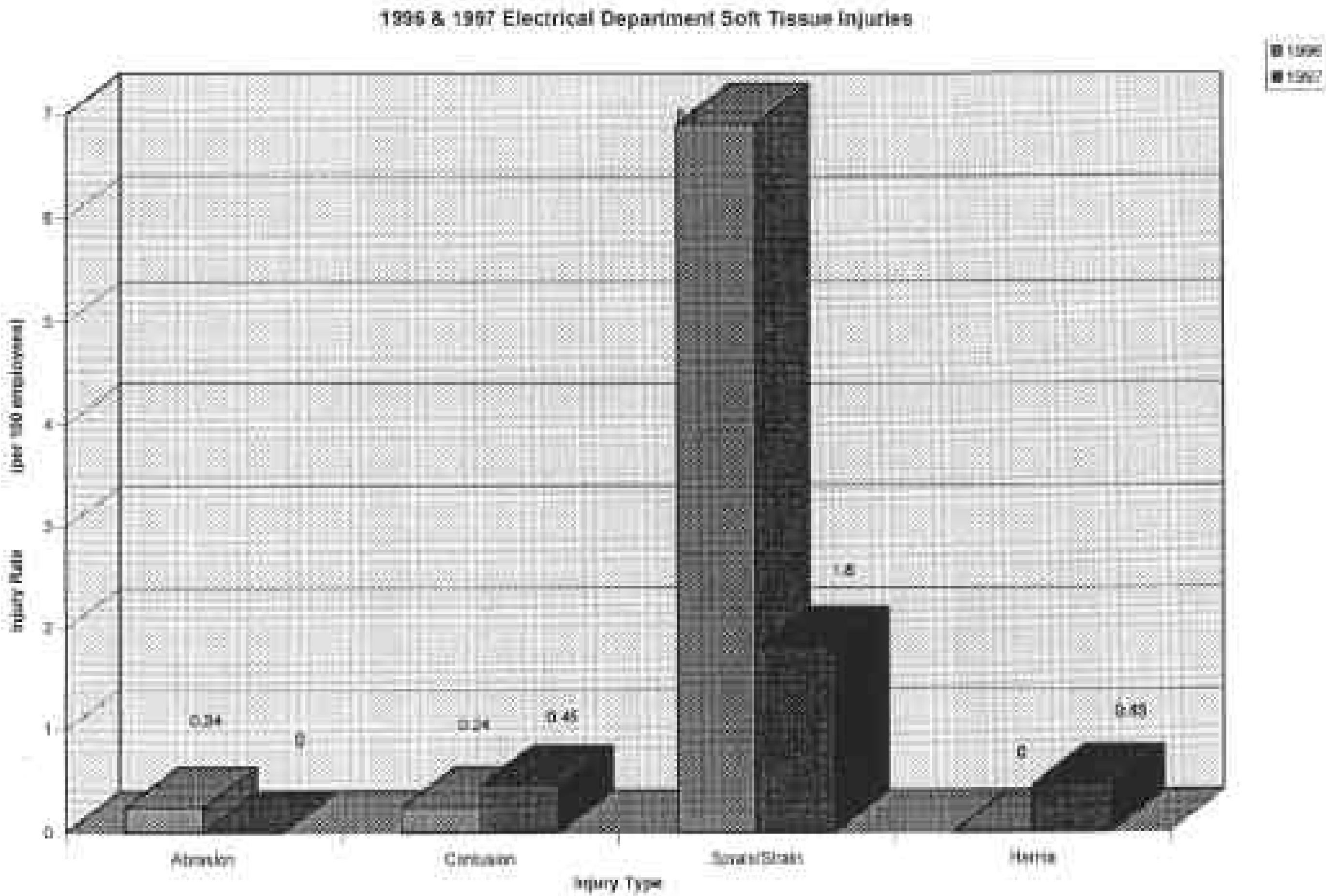

1996 & 1997 Electrical Department
Lost Time Injuries
Injury Rate (per 100 employees)
3
2.5
2
1.5
1
0.5
0
0.71
2.2
0
1.22
Home
Restricted Duty
Lost Time
Medication
First Aid
Type of Lost Time
1996
1997

Figure 1



1996 & 1997 Electrical Department Soft Tissue Injuries
1996
1997
Injury Rate (per 100 employees)
0
1
2
3
4
5
6
7
0.24
0
0.24
0.45
1.8
0
0.45
Abrasion
Contusion
Sprain/Strain
Hernia
Injury Type

Figure 2

Survey Questionnaire Responses

Question #2

How Do You Know When You're Involved in a Potentially Dangerous Situation or Work Task?

1. Looks at Surroundings
2. Extra Careful
3. Gut Feeling
4. Nature of Job, Location, and Experiences
5. Experience
6. "You Don't Feel Right About It"
7. Cluttered Area with Lines and Leads
8. ?? (Says She's Never Been in One)
9. (No show)
10. Common Sense
11. Sight, Sound
12. Common Sense
13. Gut Feeling
14. Common Sense
15. Experience
16. Gut Feeling
17. Type of Job
18. Surroundings

Answer Breakdown:
Common Sense: 3
Experiences – 3
Gut Feeling – 4
Job – 2, Surroundings – 3
No Answer – 2, Other 2

Survey Questionnaire Response

Question #13:

What Three Things Can Electrical Dept. Employees Do To Reduce Back, Muscle, and Tendon Injuries?

1. Stretching
2. Back Braces
3. Warm Up
4. Exercise
5. Continuous Training (Safety)
6. Housekeeping
7. Breaks (water)
8. Proper Rest
9. Rotate Job Assignments
10. Attention to Surroundings
11. Follow Rules
12. Proper Lifting Techniques
13. Proper Use of Equipment
14. Better use of Existing Equipment
15. Know Personal Limitations
16. Change Positions Occasionally
17. Play Smart
18. Protect Self
19. Recognize Hazards
20. Teamwork
21. Better Informed
22. Weight Belts
23. Limber Up
24. Prepared to do the Job
25. Be “In Control” When Working
26. Shorter Ladders Available on Board
27. Need to be in and Stay “In Condition”
28. Avoid Getting into too Much of a Hurry
29. Listen to Your “Gut Feeling” about/in a situation
30. Do Away with rolling Scaffolds
31. Only “Physically Fit” Should Perform Continuous Heavy Lifting
32. Employees “Hand Picked for Pulling Heavy Cable
33. Employees should Take Their Time
34. Think of an easier way to do the Job

Survey Questionnaire Responses

Question #14:

How Does Personal Responsibility Play a Role in Preventing Injuries?

1. Knowing Limitations

2. Prevents Injuries

3. “A Mental thing”

4. Fear of Losing Job

5. By communicating

6. Things of family

7. “Will Better control Your Actions”

8. More Conscientious and Aware

9. (No show)

10. In Decision Making

11. Have to be Vigilant

12. To Set an Example

13. “Helps you Know when Something is Wrong”

14. “For Myself, For My Injries, Not for Others (Injuries)”

15. “A Big Role”

16. Personal Awareness

17. (Same as above)

18. Helps to Keep Everyone Productive and Safe

Figure 3

THERAPY
SPECIALISTS
PHYSICAL OCCUPATIONAL SPEECH HAND

BACK INJURY PREVENTION

Back injuries are among the most common and most expensive to the employer. 80% of the population has or has had difficulty with their back. 60% of these individuals will have recurrent back injuries to some degree. It is important that we know as much about our backs and how to safely take care of them.

The concepts that are important to understand are the following:

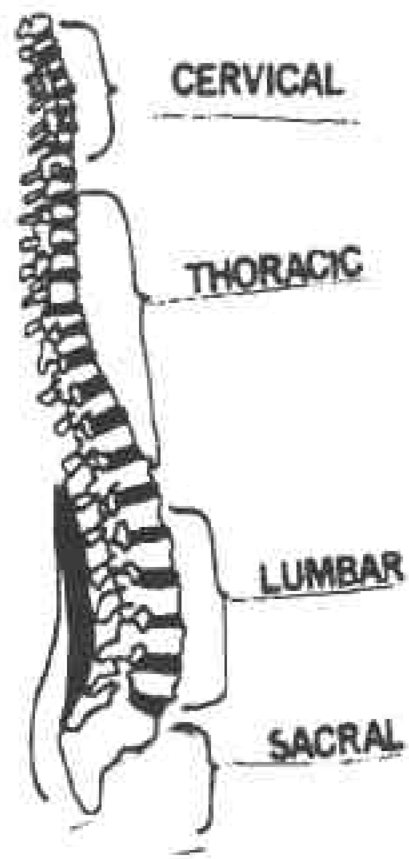
1. The anatomy of your back and how it functions best
2. Neutral Back
3. Hinging
4. Bracing
5. Conditioning and Healthy Behaviors
6. Symptom management Strategies

It is important that you apply the above principals to your daily life.

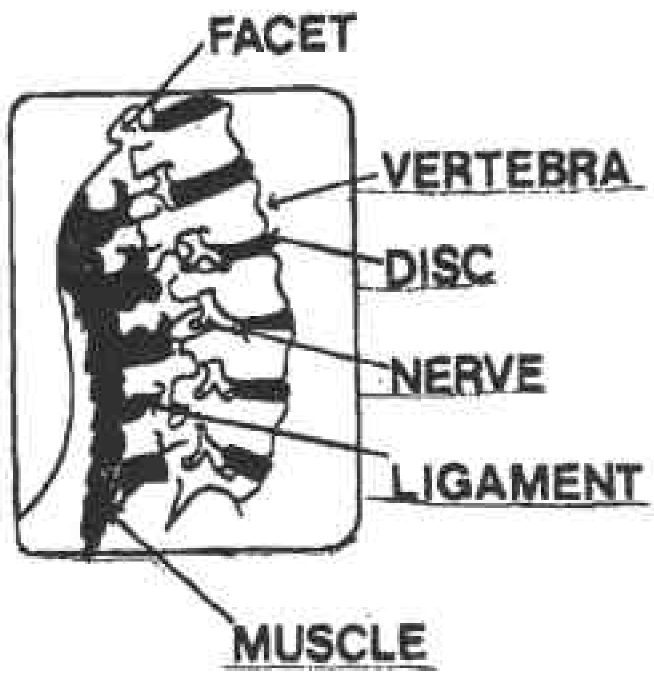
HOW YOUR SPINE IS BUILT

In order to know the difference between correct posture and incorrect posture, we must first have a good understanding of how the spine is arranged.

The spine is made up of 26 small bones, called vertebrae, stacked on top of each othe. The main functions of the vertebrae are to protect the spinal cord, provide a fulcrum for movement, and serve as a point of attachment of muscles that hold the body upright. Vertebrae are classified into five groups by their shape and function. The areas most affected by posture are the cervical area, or neck; the thoracic area where the ribs connect; and the low back or lumbar area. While the sacrum is one solid bone, the connection between the sacrum and the lumbar area is a common area of pain if the angle is larger than it should be. This angle is very important when considering the mechanics of good posture. The concepts of NEUTRAL SPINE, BRACING, HINGING, WEIGHT SHIFTS, BASE OF SUPPORT AND CENTER OF GRAVITY, will be discussed later.



Between the vertebrae are fibrous "cushions" called intervertebral discs. These act as shock absorbers to protect the vertebrae and brain and allow motion between the vertebrae. It is this motion which allows you to bend over or look over your shoulder. The facet joints, which are formed by the overlapping of two vertebrae, are responsible for guiding this motion of your spine. Spinal nerves exit the spinal column between the vertebrae near the disc and facet joints. These nerves control all functions of the body and vital organs including movement and sensation. Last, but not least to be considered, are the muscles and ligaments which support the spine and hold it in an upright position. The most important of these are the stomach muscles which should be strong and in good condition, not weak and saggy.



Your leg and back muscles when strong help to support the back as well. When you are able to maintain your back in neutral, brace with your abdominals, hinge and wt. shift you can use your center of gravity to yourbenefit. The forces on your low back are significantly decreased and your muscles and ligaments have the advantage. It is important that you understand these concepts. Below are definitions of these important concepts.

NEUTRAL SPINE: The position in which the three natural curves of the spine are in their most balanced, safe and efficient alignment. Since anexcessive arch (sway back "sagger") and a decreased arch (flat back "sloucher") can cause low back pain, that is why it is important to prevent both extremes and maintain your spine in a neutral position.

BRACING: Voluntary abdominal (stomach) contraction to maintain your spine in neutral and protect your low back. This technique stabilizes the spine during loaded or weight bearing activities. REMEMBER bracing is not a sucking in of your stomach muscle. Imagine that you have a wt. lifting belt across your stomach, you tighten (push your stomach muscle out) into the belt. Do not arch your back. We tighten these muscles naturally when we laugh .

HINGING/AXIS OF MOTION : The joint or joints at which movement is occuring. The goal is to shift the axis of motion from the spine to otherjoints. The hips, knees, and ankles have their own naturally occuring hinges. When the proper hinges are utilized the muscles and ligaments are working most effectively.

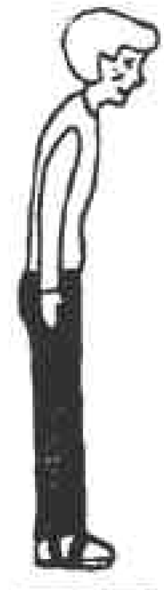
WEIGHT SHIFT: Transfer of weight from one stable point to another. All movement is initiated with a weight shift.

BASE OF SUPPORT AND CENTER OF GRAVITY:
Greater stability is obtained by : 1) lowering your center of gravity
2) widening the base of support in the direction of of the line of force
3) keeping external forces or objects nearer to the center of gravity

While the short and long term effects of poor posture are many, those that cause most concern are the ones which cause pain in the low back. To summarize poor posture causes the following effects on your low back:

1) Increased risk of pressure on the nerves due to degeneration of spinal structures.

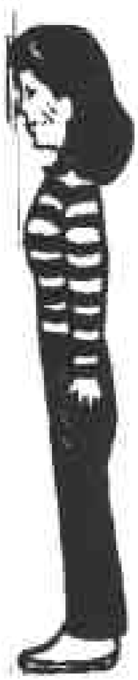
2) Poor mechanical leverage for the muscles and structures when lifting or doing heay work.



3) Strain on the muscles and ligaments of your back and neck, leading to rapid fatigue and discomfort.

4) An abnormal curve in your low back leads to an abnormal curve in your neck, and vice versa, because the curves of your spine try to balance and compensate for each other.

PROPER BODY ALIGNMENT



Center your head over your shoulders, slightly tuck your chin.

Balance your shoulders over your pelvis. Your shoulders should not be rounded or arched.

Your pelvis should be level and your abdominal muscles braced. This will decrease the arch in your back.

Keep your knees straight but not locked.

Spread your feet a few inches apart so they are aligned with your hips. This gives you a wide base of support and greater stability. Distribute your weight evenly between your heels and toes.

CONDITIONING AND HEALTHY BEHAVIORS

Most back pain is the summation of many small aggravations to your back. Each of these aggravations may be insignificant; but when they are added together, cause irritation and inflammation which eventually results in spinal degeneration. This chronic irritation caused by these repeated aggrevations makes it easier to injure your back, and episodes of back pain become more frequent.

If you maintain your spine in correct alignment, keep the muscles surrounding it strong and flexible, exercise on a daily basis, and sleep and eat well you will decrease the risk to your back. It is important that you are the proper weight for your height. Excess weight decreases abdominal support for your low back and puts additional strain on your vertebrae. Good nutrition is necessary for achieving and maintaining good physical condition. Keep junk food and alcohol to a minimum. A good night's sleep prevents fatigue, thus decreasing the chances of re-injury. When choosing sports of activities, consider good exercise principles and avoid abrupt movements.

Your physical condition has a large influence on how you feel. Being in "good shape" makes activities easier, thereby enabling you to do your daily routine with energy to spare. Your tolerance to pain is also increased and it is a healthy outlet for relieving stress. With increased exercise your heart becomes more efficient and circulation and nutrition to your tissues improves. The quality of your sleep improves as well. Make sure that the exercise activity that you choose can be done regularly and frequently. Remember to maintain good spinal alignment during your activity.

Recommended activites include:

WALKING

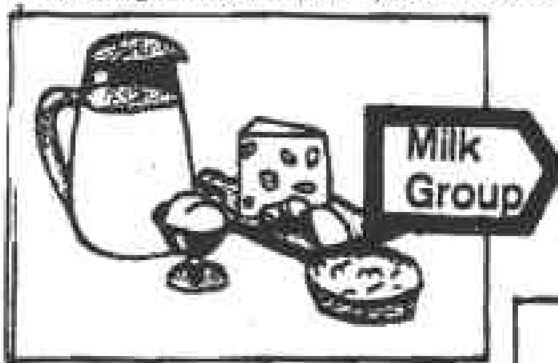
HIKING

BIKING

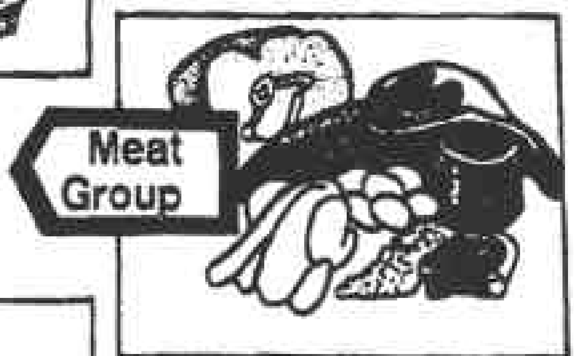
SWIMMING

SO WHAT DO I EAT?

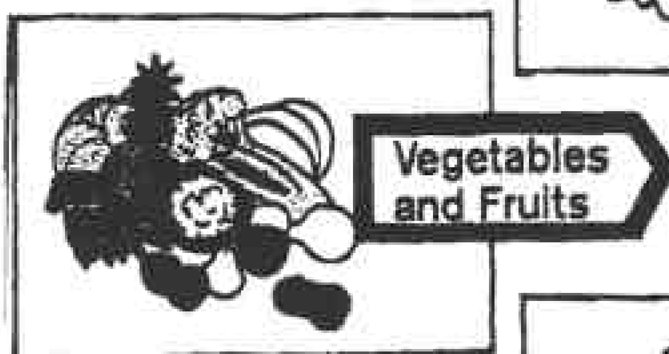
In order to get all the nutrients your body needs, five food groups should be included in your daily diet.



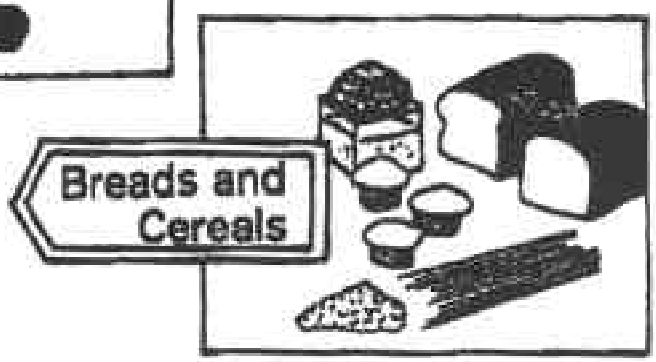
2 servings a day for adults, 3 for children and 4 for teenagers. Provides protein, calcium, phosphorous, and several vitamins. This group includes milk and milk products such as cheese and yogurt.



2-3 servings per day. Provides protein, iron, zinc, Vitamins B_6 and B_{12}. Foods included in this group are meat, fish, poultry, eggs, legumes, and nuts.



4 servings per day. Provides vitamins, minerals and fiber. Include a variety from this group in your daily diet.



4 servings per day. Provides B vitamins, iron, fiber, and minerals. Products made from whole grain or enriched flour, rice, and cornmeal are included in this group.

This group provides mostly calories, so there is no recommended number of servings per day. Amounts eaten should be guided by caloric needs. If you're overweight, you'll want to avoid these foods as they are high in calories. If you're underweight, they are a good source of extra calories, but don't use foods from this group in place of the other four groups because they are low in nutrients. Butter, margarine, oil, salad dressings, fried snack foods, cake, cookies, candies, and numerous other items are included in this group.

THERAPY
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THESE BACK CONCEPTS CAN BE TAUGHT AND UTILIZED FOR ANY TYPE OF JOB. THE BETTER THE UNDERSTANDING THE SAFER THE WORK ENVIRONMENT WILL BECOME. THERE WILL BE LESS INCIDENCE OF BACK PAIN NOTED.

FOR SPECIFIC INSTRUCTIONS ON HOW TO APPLY THESE CONCEPTS IN A PARTICULAR AREA AND TO GAIN SPECIFIC KNOWLDEGE OF THE GENERAL CONCEPTS, PLEASE CALL THERAPY SPECIALISTS AT 2818-4900. JEANETTE BARRACK P.T.

Education onYourAir Belt* Back Support

The AIR BELT ... **Principles of Operation**

Pictures not available

It is a uniquely designed inflatable lumbar support, which can be conveniently worn inside or outside of clothing without restricting mobility. The Air Belt lumbar support acts to reduce the risk of muscular lower back discomfort. The interconnected chambers conform to your back when air is added. As the chambers fill, they apply forward pressure over the muscles. This pressure promotes muscle relaxation and encourages the proper alignment of the lower back.

QUESTIONS OFTEN ASKED ABOUT THE USE OF THE AIR BELT

Does the Air Belt weaken muscles?
By allowing a full range of motion, the Air Belt does not weaken muscles. Individuals will use their muscles in a normal manner.

Does the Air Belt only remind the user to lift properly?
Lifting properly or working smarter is a function of training. Reminding is a positive reinforcement of training. Safety products do remind but worthwhile products have their own functionality**.** The Air Belt helps to eliminate unwanted lower back contractions. This will reduce fatigue and residual back pain that will occur if unwanted contractions from work go unchecked. TheAirBelt helps maintain proper
your waist
posture by placing pressure on shortened muscles, allowing them to return to their normal resting length to promote proper spinal alignment. This alignment is often expressed as keeping your head and shoulders over your hips. This alignment should be stressed when lifting, standing or even when you are seated.

Does the Air Belt cause a false sense of security?

The need for ongoing training and understanding of the product cannot be overstated.
You must recognize that back belts do not make you stronger!! It is by providing ongoing training that the wearer will understand this fact. Each individual must recognize their own limitations and act within them. Your employer appreciates your input and suggestion regarding your workplace. Safeguard Technologies will assist in a comprehensive ap proach to reducing the occurrence of back injury by making available training aides and programs. Each of our back sup ports has a warning label to remind the wearer of the belts limitations and the need to act in a responsible manner.

IMPORTANT FACTS ABOUT THE AIR BELT

Instructions: Each belt comes with a complete set of oper ating instructions.

Sizing: When determining belt size, add 2" to

measurement if belt is being worn over clothing.

Care *of the Air Belt:* Your Air Belt can be scrubbed by hand with a mild detergent in warm water. Air dry. Do not ma chine wash or place in a dryer.

Warning: This is only a support belt and should not be con sidered a remedy for back problems. If you are under the care of a health care practitioner, consult with them before using your Air Belt'. This belt will not guarantee freedom from all back strain. Always utilize good judgment and proper lifting techniques, especially when objects are below 30 inches from the floor. This belt is not to be used as a safety device with a tether line against slipping and falling. Not a flotation device.

Figure 5

E.L.A.T.E.

ERGONOMICS. LIFTING. ANATOMY. TRAINING. EDUCATION

How to Reduce Back Injuries on the Job

Discussion on what ergonomics is and
how it affects our bodies

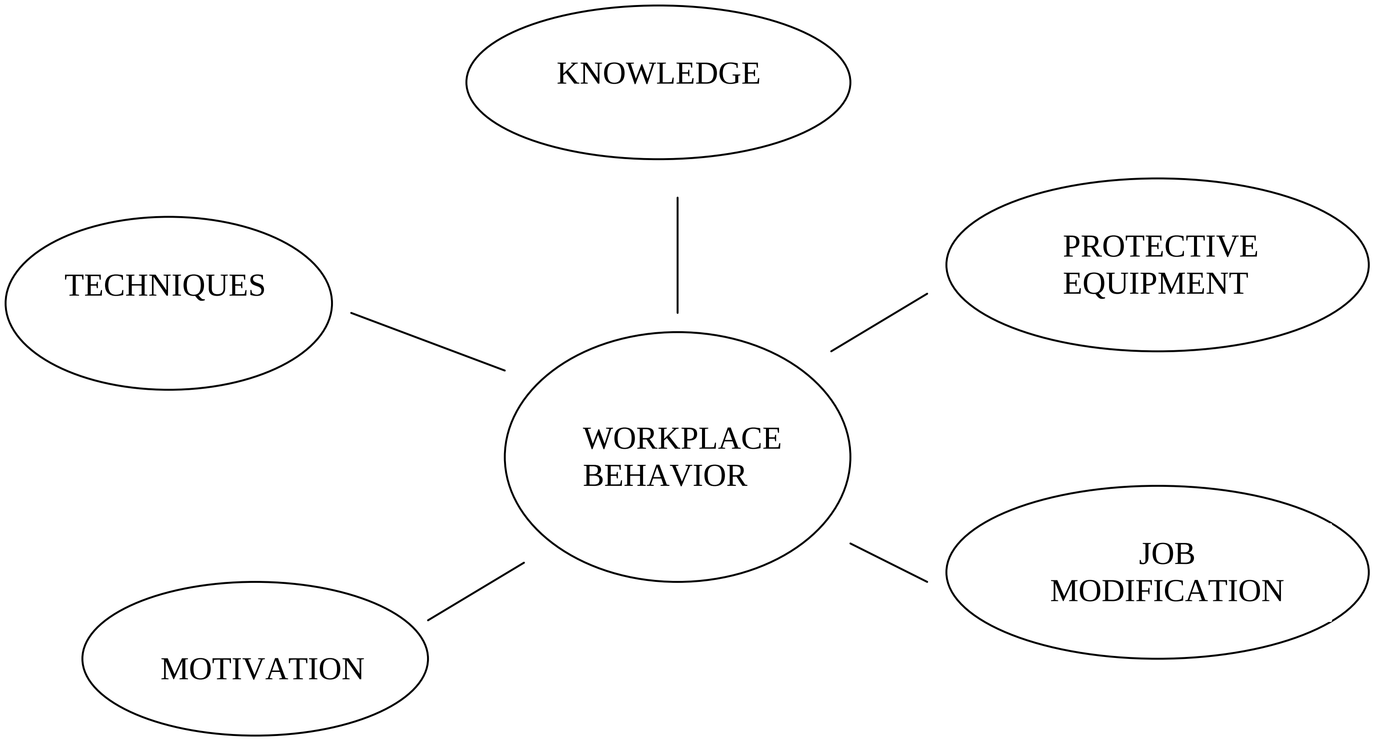
What are the causes of back injuries

The effects of back injuries and
What it means to you and your company

Training on proper lifting techniques

Complete education on all products
Including care and proper use

DEVELOPMENT OF GOOD WORK HABITS



Sweat Equity

How much production in sales dollars does your company spend to pay for back injuries?

- National Safety Council says the direct cost of a back injury ranges from $11,000 to $17,000.

- The next slide shows a chart which was prepared using data provided by Citibank of New York. It states in sales dollars how much a company in various classifications surrenders to pay for an average back injury, using $11,000 as the cost basis.

- Multiply the sales amount by the total number of back injuries to determine the yearly effect on your company.

Sales Required to Pay For the Direct Cost of a Back Injury

Aerospace	234,035	Department, Specialty Stores	340,355
Air Transport	647,065	Distilling	180,335
Amusements	90,905	Drugs, Medicine	103,775
Autos, Trucks	423,080	Electrical Equipment, Electronics	211,530
Automotive Parts	244,440	Electric Power, Gas	123,590
Baking	305,560	Farm, Constructn, Mat'l Handing Eq.	189,660
Brewing	41,910	Food Chains	846,164
Building, Htg, Plumbing Eq.	177,430	Food Products	289,475
Cement	106,790	Furniture, Fixtures	343,750
Chemical Products	177,450	Glass Products	215,690
Clothing, Apparel	220,000	Hardware, Tools	207,540
Common Carrier Trucking	314,295	Household Appliances	265,290
Construction	398,840	Instruments, Photo Goods	127,900
Dairy Products	323,530		

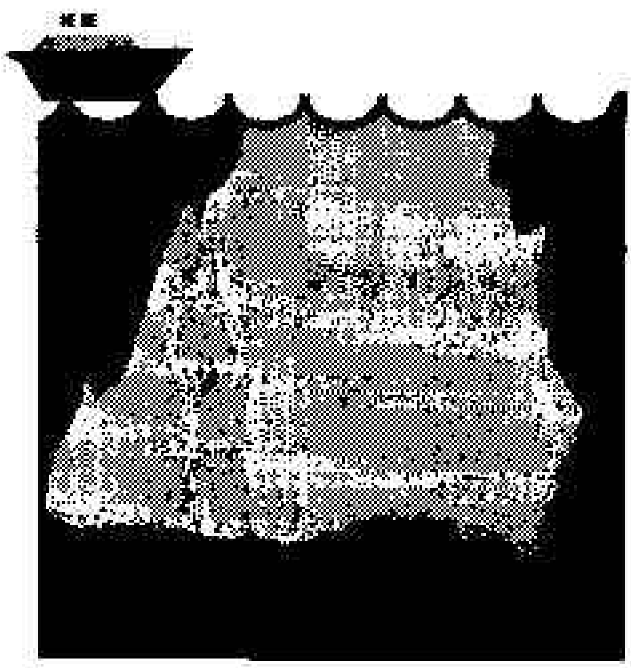
Sales Required to Pay for the Direct cost of a Back Injury

Iron, steel	323,575	Railroads	314,295
Lumber, Wood Products	141,020	Restaurants, Hotels	180,335
Machinery	186,450	Rubber, Allied Products	578,950
Meatpacking	1,000,010	Shoes, Leather Goods	323,535
Metal Mining	55,835	Soap, Cosmetics	180,335
Metal Products	260,910	Soft Drinks	174,815
Nonferrous metals	152,770	Stone, Clay Products	203,700
Office Equipment, Computers	99,110	Sugar	229,165
Paint, Allied Products	407,420	Telephone and Communications	94,820
Paper, Allied Products	166,715	Textile Products	343,750
Petroleum Products, refining	177,870	Tobacco products	183,325
Printing, Publishing	157,145	Variety Store chains	458,325
Quarrying, Mining	164,625	Wholesale Houses	450,200

Hidden Cost of Accidents

Direct:

- Medical



Indirect:

- Economic loss to injured family
- Lost efficiency due to breakup of crew
- Lost time for extra supervision
- Cost of training replacement
- Spoiled work
- Less production
- Failure to f.ll orders

Contributors to Back Injury

- Lifting, twisting, bending incorrectly
- Poor posture
- Fatigue
- Accidents
- Sports related injuries
- Diet
- Genetic predisposition
- Stress
- Heel strike

The above noted situations generally are contradictory to maintaining the natural "S" curve of the back.

Ergonomics:

The function of designing and

adjusting the workplace to the worker

to achieve safety, injury avoidance,

health, productivity and

improved morale.

Ergonomic Evaluation

- Worksite – equipment/layout
- Work practices – how tasks are done, frequency, bulk, weight, duration
- Employee capabilities – may require medical input
- Define change – and cost
- Prioritize action
- Measure results

Understanding Your Back

Your spinal column consists of 24 bony vertebrae which are stacked one upon another; they are separated by discs which act as shock absorbers.

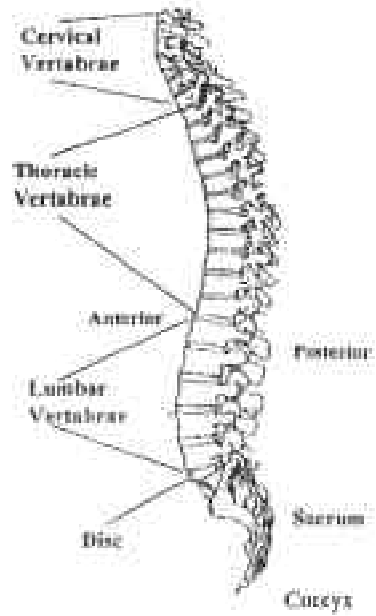
The neck area is called the cervical region, consisting of seven vertabrae, and curves forward.

The mid-back area has twelve vertabrae and is called the thoracic region. This curve is backward.

The lower back area is called the lumbar region and is made up of five vertabrae, which curve forward.

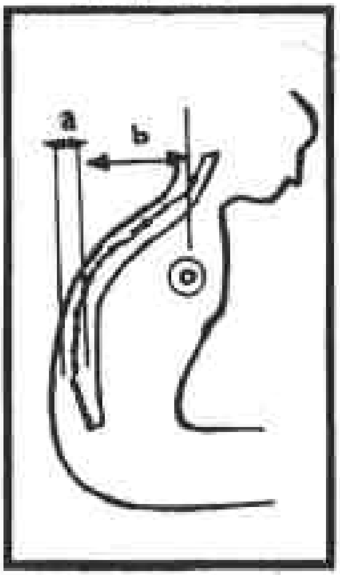
Below the lumbar region is a solid mass of bone called the sacrum.

The muscles of the back control the shape of the spine.



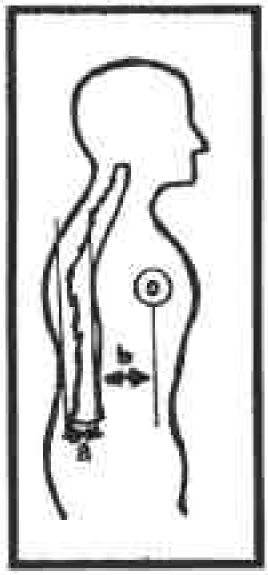
Spinal Alignment

Improper



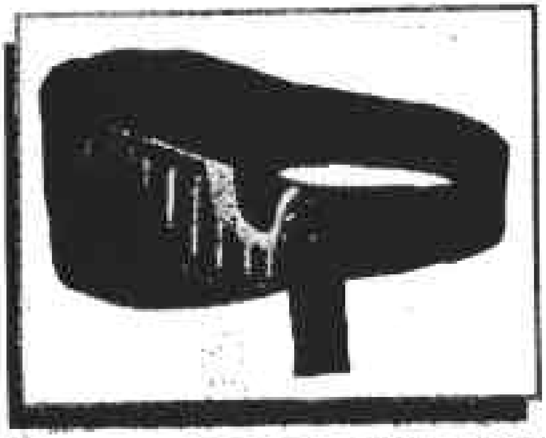
Sitting and leaning forward tend to make the back work harder

Proper

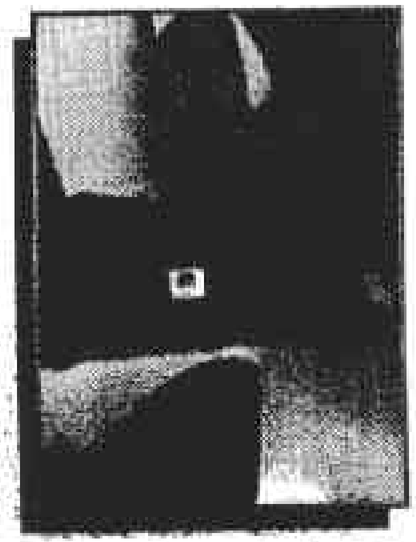


As dimension "a" increases relative to dimension "b", back muscle activity decreases

Air Belt Principles of Operation

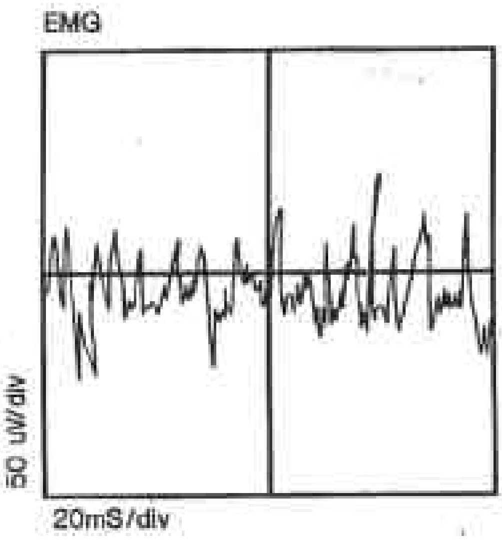


Interconnected chambers uniquely conform to your back as air is added.

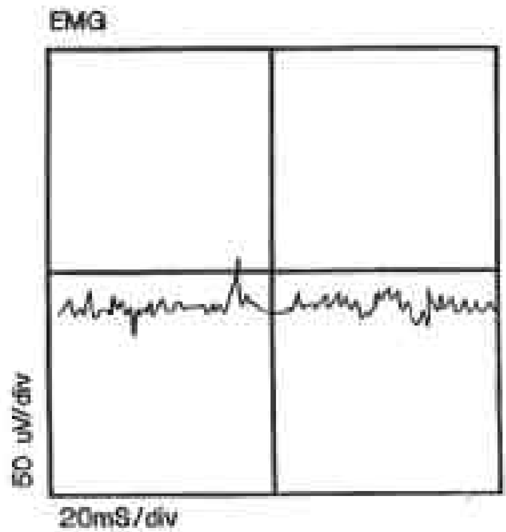


Creates forward pressure to support muscles of the back.

Air Belt Electromyographic Recordings



Without Air Belt



With Air Belt

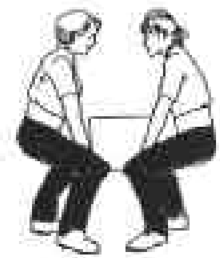
Air Belt Addresses Most Commonly Cited Concerns About Back Belt Usage

- Air Belts do not weaken muscles
- Air Belts do more than remind the user to lift properly
- For properly trained users, Air Belts should not cause a false sense of security

1. Think

Size up your load. Think about the weight and the bulk that you want to handle.

2. Ask for help



If you need assistance, request it. When lifting with another individual, make sure you lift and lower together. Choose one person to give the signals.

3. Firm footing

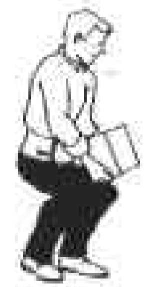
Get a firm footing. Keep your feet apart for a stable base and point toes outward. Do not lift when off balance.

4. Bend knees

Bend your knees, not your back. Do not bend at the waist. Keep principles of leverage in mind.

5. Tighten stomach muscles

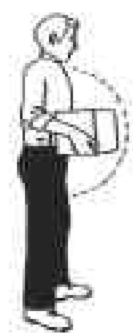
Tighten your stomach muscles before lifting. Abdominal muscles support your spine when you lift.



6. Legs, arms, back

Lift with legs, arms and back muscles. They can all help do the work of lifting. Don't totally depend on your back muscles.

7. Safe lifting range



Keep load close. If possible hold both forearms against your body at waist level and your hands near your stomach. At minimum keep your elbows near your sides, with hands moving between shoulders and thighs.

8. Shoulders over hips

Keep back upright and shoulders and hips lined up. Whether lifting or putting down the load, don't add the weight of your body to the load by bending forward.

9. Pivot feet to turn

Avoid twisting by pivoting your feet. Move your whole body in the direction of the turn.

10. Path to destination

Know where you are going. Have a clear path and the shortest distance to your destination. If you use carts, dollies, ladders, etc. make sure they are sturdy and in good repair. When using carts, hand trucks and dollies, push rather than pull.

11. Lower slowly

When lowering your load, remember to have a firm grip on the object. Lower your entire body slowly, bending the knees and keeping the back upright. Do not use a jerky motion or twist while lowering.

12. Lowering same as lifting

If possible try to unload onto a surface that is waist high. If this is not possible, exercise extreme caution as the danger of injury increases as you move lower.

STRETCHING EXERCISES

All exercises should be done slowly and smoothly, avoiding jerking motions. Hold for 5 count.

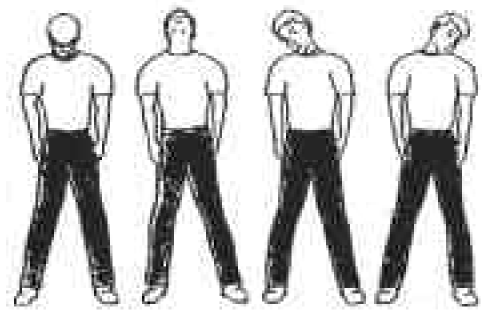
NECK

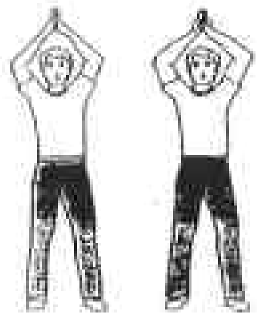
Flexion: Bend head down, chin to chest.

Extension: Bend head back, chin pointed up.

Sidebend: Tilt right ear to right shoulder. Tilt left ear to left shoulder.

Rotation: Turn chin toward right shoulder. Turn chin toward left shoulder.

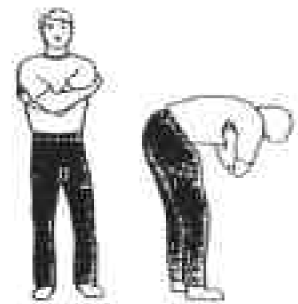




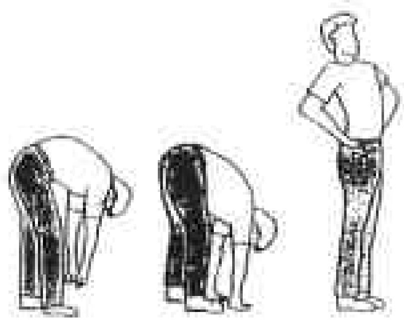
SHOULDERS

Reach arms up above head, hold palms together. Keep arms up, turn hands to touch backs of hands together.

Shoulder Blade Area



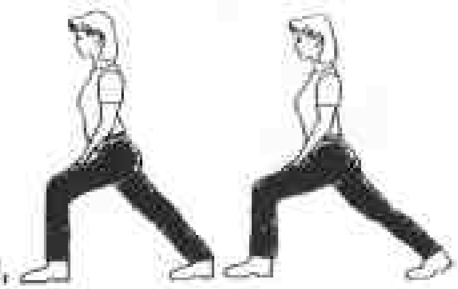
Reach across body with each hand holding the opposite shoulder (hug yourself). Tilt head and upper body forward. Hands around back of arms onto shoulder blade.



Low Back (Flex / Extend)

Bend knees slightly, bend straight down, reach hands down as far as possible. Come back up to straight position, place hands on hips, and tilt body backwards.

Leg Stretch   (Calf / Thigh)



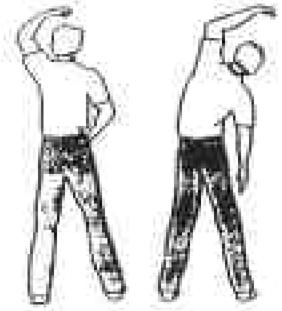
(1) Place left foot forward; right back, toes pointed Straight ahead. Keep heels on the ground and lean forward to stretch calf.   (2) Let heel come off ground, lean forward and press against raised foot to stretch upper thigh. Reverse position, stretch other side.

Half Squat   (Quads / Groin)

Spred legs, shoulders square with toe pointed out, with hands on knees, squat down half way. Keep back straight. Hold for 5 count.

Low Back (Sidebend)

Reach right hand up over head. Tilt body to left, reaching left hand down to left knee. Reverse hand position and bend to right.

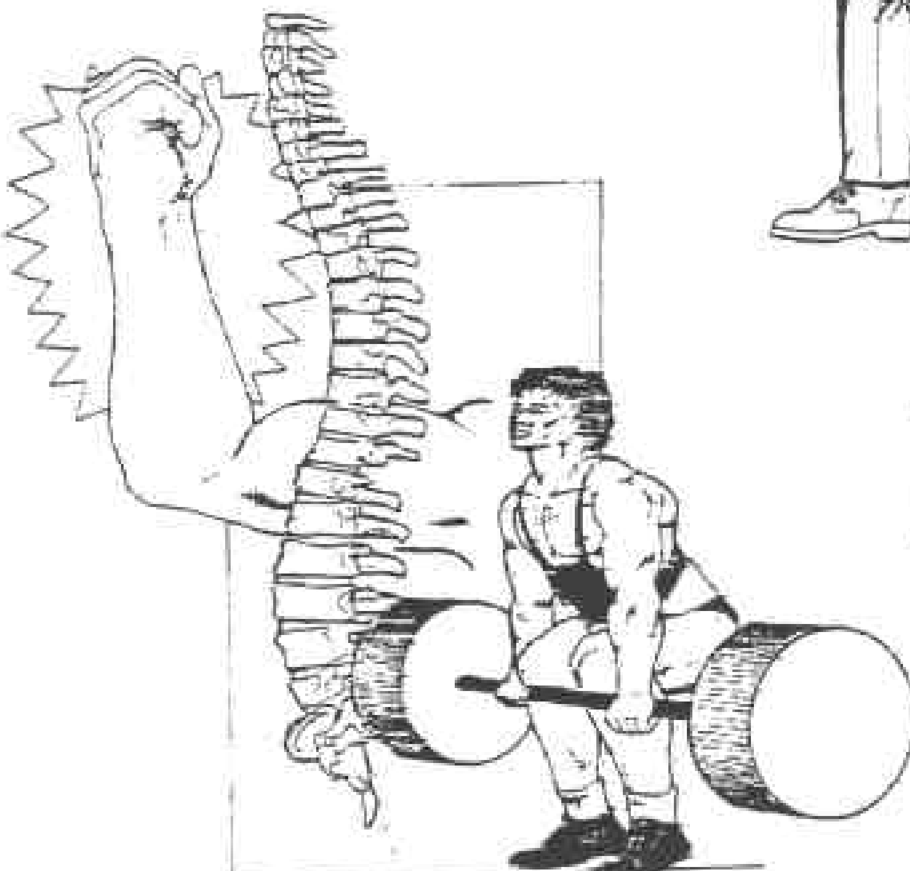


Trunk Rotation

Place hands on hips, twist body to left, then to right as far as you can. Keep feet still.

Figure 6

On the Road:
The Lighter Side of Lifting



Trainer's Manual

BNA Communications Inc.

On The Road: The Lighter Side of Lifting

Summary

Subject

A way to lift that protects the back by limiting and distributing stress and exertion.

Running time

22 minutes

This video...

- Explains a better way to lift that stresses weight distribution, stance, and warming up and relaxing.
- Shows various types of lifting activities and how approach can alter strength, back stress, and efficiency.
- Motivates workers to think before they lift any object, whether heavy or light.
- Stresses the need for staying attuned to body position and work environment as a way of protecting the back.
- Gives you the chance to explain your policies on lifting and to discuss use of back supports, equipment, or other assistance you offer.
- Can be used for training new employees and for refresher training.

Table of Contents

Trainer's Manual

Before training begins. . .

Plan the session

Arrange for a location suitable for the training session. Ideally, the room should be comfortable and seat all participants in a quiet location. You should be able to darken the room to make viewing easier. The video monitor must be close to an electrical outlet and in a position where everyone can see it.

Reserve the audio/visual equipment and the video for the day and time needed. Check the equipment to ensure that it is in the proper format and in working order.

Read through all the materials in this manual, including the trainer's manual and the participant's manual. Be familiar with the subject and ready to answer questions, or arrange for an expert to join you during the training session.

Notify those you want to attend and their supervisors.

Gather materials

Photocopy:

- A participant's manual for each participant.
- The participant's quiz, one for each participant.
- The answer key for the trainer. Copies of this may also be given to participants after they take the quiz.

In addition,

- Collect and review pertinent company policies related to the training. If you plan to distribute these to participants, you should make enough copies.
- Gather safety equipment or other items that will be part of a demonstration.
- Bring a wristwatch or clock to time the session.
- Provide pencils or pens for all participants.

Final set-up

Before the participants arrive on the day of training:

- Set up the room so everyone can see the Trainer and video monitor. Include space for the trainer's materials.
- Distribute the materials, one set at each participant's seat.
- Insert and cue the video and check the sound level.

You're ready to begin the training.

Lesson Plan

Opening remarks (5 minutes)

Read or paraphrase the following.-

""Today we are going to look at the subject of lifting. Go ahead, you can groan. But before you tune out, think about all the people you know with back problems. Few things are as uncomfortable and potentially disabling as a problem back. A sore back affects every move you make, from sitting to reaching to sleeping. And although years have been spent talking about protecting your back, back injuries still are rampant in every workplace. Let's face it. We've been teaching people how to lift for years and people still have back problems. Maybe it's time for a new approach."

Now explain the organization's policies and procedures related to lifting and back injuries. Remind participants that lifting safely will protect their backs and help them work safe and smart.

Hint: It is good to relate incidents in your workplace where lifting is done on a regular basis. Also note how much reaching and lifting is done by people who have jobs that are not physically demanding. Ask participants to relate personal examples.

If you choose to share statistics on back injuries for your organization, this is a good place to mention them.

Introduce the video

Read or paraphrase the following.-

"We are now going to watch a video that takes a new look at lifting. Instead of all the rules that are so difficult to remember each time you reach, this video presents a simplified way of taking the load off your back. As you watch the video, try to think about how it relates to your work experience here."

Show the video (22 minutes)

Ask for questions

Answer any questions. Make sure you have an expert there if you think you might need one. If you don't know the answer, say so, but promise to get the answer and contact the person. Remember to do it.

Demonstrations (10 minutes)

Set up several scenarios similar to those in the video: a box, a bucket on the other side of an obstacle, and a small package on the far side of a table. Ask participants to lift them using the information they learned in the video. Make sure to remind them to stretch and warm up first.

Review generally your policies on lifting and when to get assistance, either human or mechanical.

If applicable, explain your policies on back supports and demonstrate their proper use. Review also your policies on reporting workplace injuries and/or accidents.

Administer the safety awareness quiz and review it (10 minutes)

Ask the participants to complete the quiz that you distributed. Make sure they know that the quiz is not a condition of employment. It is a self-check of the points made in the session.

Review the quiz with the participants, giving them the correct answers from your answer sheet. Pass out answer sheets if you decided to do this. Then collect the quiz. It can be filed as evidence that training was completed.

Closing remarks

Read or paraphrase:

> "Thank you for your participation today. Remember that our backs don't come with owner's manuals. And that the most effective way to lift starts in our heads, not our backs. Lifting better is about thinking how you can minimize the demand of every lift you make.
>
> "If you have any other questions, I will try to answer them or you can ask your supervisor."

Make sure you store the quizzes as documentation that the training was done.

Participant's Manual

What will work for our backs

Think about all the people you know with back problems. Few things are as uncomfortable and potentially disabling as an injured back. A sore back affects every move you make, from sitting to reaching to sleeping. And although years have been spent talking about protecting your back, back injuries still are rampant in every workplace.

Let's face it. We've been teaching people how to lift for years and people still have back problems. Maybe it's time for a new approach for taking the load off your back.

The old approach

In the past, most discussions about how to lift centered around a long list of rules. Some of the more common lists included "approach the load" and "test the load" through "tighten the abdomen," and "lift with the knees." Yet for most people about to lift something, their most common thoughts are "Can I pick this up?" and "Where am I going to put it?" With so much to think about, no wonder so many people strained and even injured their backs.

Back basics

The spine is composed of vertebrae with cushioning between that allows the spine to bend in several directions and twist. Its natural position is a slight "S" curve that begins at the neck and ends at the tail bone. The back is most comfortable in this position. It is also strongest and most functional in this shape. Stretching the back straight out or into a "C" shape are weaker positions and reduces the effectiveness of the cushioning disks.

There is also the effect of load. Every time a person bends into a "C" shape or flattens the back straight out, the load tends to be lifted from the hips. But the load in this position is not only the item being lifted, but also the entire upper body. It's as if the entire upper body is swinging out into thin air with nothing to support its weight. Then the weight of the item being lifted is added.

Lifting and bending in this way often results in back discomfort. It's one reason why people sometimes injure their backs when reaching to pick up a piece of paper or some other light object. They don't realize that the object actually being lowered and then lifted was their entire upper body and head! Not a light load at all.

That brings us to the two basic elements of this new approach to lifting:

- Keep the curves, and
- Keep it close.

If we can keep the curves in our spine as natural as possible and keep the load close to our bodies, we can reduce the strain on our backs and reduce the risk of back injuries. We'll also be working with the structure of our backs and bodies and with gravity, instead of against them. There are several ways to accomplish this.

Build a bridge

Many times when we lift we can take much of the load off our backs and put it someplace else. This is called building a bridge.

If an object can be lifted with one hand, we can lean the other hand on some solid object or on our flexed knee. Let the object or the knee support the weight of the upper body. This keeps our center of gravity, the place of our greatest body mass, more centered over where we touch the ground. It keeps our upper body mass from swinging out in midair with only our back to support it.

If two hands are needed for the lift, we can go down on one knee. This also keeps our center of gravity over our feet instead of in midair. This position can be much stronger and much more balanced than squatting over the object being lifted.

Building a bridge is one way of following the two elements of this lifting method: keep it close and keep the curves.

Staggered stance

Another way to keep it close and keep the curves is to watch where you put your legs. Many people don't realize it, but how you stand has a lot to do with how you lift.

Keeping your legs close together forces your body to bend into a "C" shape at the lower back. On the other hand, separating your legs, with one forward of the other, gives a wider base of support and makes it easier for the legs to get involved in the lift.

The wide, staggered stance lowers your center of gravity and helps you keep the weight being lifted closer to your body. Your back moves very differently when your legs are further apart. You are more balanced. Your knees are flexed. And when you pick up an object in this position, it naturally stays closer to your body, your back stays in an "S" curve, and your head stays up.

Just remember that you also have to put down what you lift. Get into the habit of maintaining the wide, staggered stance when you put an object down as well as when you lift it.

Prepare and compensate

Preparing to lift is an often forgotten concept. Yet warming up a body before doing physical work makes it operate much more efficiently.

Athletes do this routinely. They stretch and bend and get their muscles limber and warm before every game. They know that warm muscles are stronger and less easily injured.

Yet we often come to work and begin lifting without warming up. After sitting for hours, we get up from a desk and lift a box off the floor or reach for a telephone book without thinking. Placing a cold, stiff back and body in this position increases the risk of injury.

Compensation is also important. This means if you are placing repeated demands on your body you have to rest and relax it. The best way to do this is to change position

and stretch. If you are lifting a lot, stop for a few minutes and straighten your legs and back. Stretch from side to side and bend in the direction opposite from the way you were just bending.

Through preparing and compensating, we get our bodies ready before placing physical demands on them and we relax and stretch them frequently while we are working.

Lifting better

Lifting is not about rules, or about a right or wrong way to perform each task. Lifting is about using our bodies in the most efficient way, in the way they work best. Therefore, the most effective way to lift starts in our heads, not our backs.

Lifting better is about thinking how you can minimize the demand of every lift you make-how you can keep the curves and keep it close.

Participant's Quiz

Name Date

Signature

Circle True or False for each of the statements below.

1. - Lifting is not about rules but about using our backs in their strongest and most natural positions.
   True False

2. Keep it close and keep the curves are two key points to remember when lifting.
   True False

3. Never use anything to support your weight when lifting. Your back should be trained to do all the work.
   True False

4. Standing with the legs separated and with one leg in front of the other makes lifting easier by shifting some of the weight from your back to your legs.
   True False

5. Warming up your body before lifting objects prepares it for work and is one way to reduce the risk of back injuries.
   True False

6. To compensate our bodies for repeated lifting we should take a long lunch.
   True False

Answer Key

1. True. Lifting is not about rules but about using our backs in their strongest and most natural positions.

2. True. Keep it close and keep the curves are two key points to remember when lifting. When we keep the load close to our bodies we keep it closer to our center of gravity and more directly over the point where our body touches the floor. When we keep the curves in our back, we reduce the strain on the muscles and allow the back's natural cushioning disks to work more effectively.

3. False. Supporting the weight of your upper body when lifting helps take the strain off your back muscles. It also helps maintain the natural curve of the back and keeps you from swinging your upper body weight into midair without anything but your back to support it.

4. True. Standing with the legs separated and with one leg in front of' the other makes lifting easier by shifting some of the weight from your back to your legs. It also helps keep your center of gravity lower and keeps the back in its more natural and stronger position.

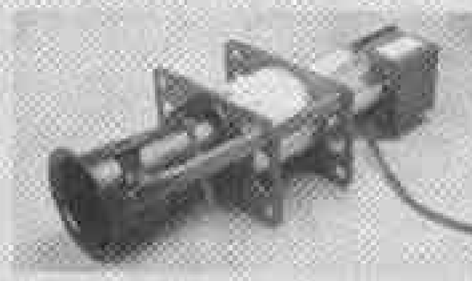
5. True. Warming up your body before lifting objects prepares it for work and is one way to reduce the risk of back injuries. Stretching, bending, and moving your muscles are ways to warm up.

6. False. To compensate our bodies for repeated lifting we should stretch and move our muscles into the opposite position. We should take a minute to straighten up our legs and backs. Bend and stretch from side to side. Taking a new position for a minute allows our muscles to relax.

Figure 7

ULTRA Tugger™

Cable Puller with Versi-Boom™ System



GREENLEE TEXTRON

Figure 7

Figure 8

Cal-OSHA Reporter™

Since 1973

A WEEKLY PUBLICATION FOR THE SAFETY AND HEALTH COMMUNITY

September 8, 1997 Vol. 24 No. 36

IT'S OFFICIAL - IT'S JEFFRESS

President Clinton has announced his intent to nominate Charles N. Jeffress as Assistant Secretary for Occupational Safety and Health at the U.S. Department of Labor.

Jeffress has served as deputy commissioner and director of OSHA at the North Carolina Department of Labor since 1993. He is widely credited with rebuilding the state program after the deadly fire at a chicken processing plant. (Many workers died because exit doors were locked. There had never been a safety compliance inspection there. At the time, OSHA threatened to federalize the state plan.)

From 1977 to 1992, Jeffress served as assistant commissioner in the North Carolina Department of Labor. He is a graduate of UNC - Chapel Hill.

LOS ANGELES DWP DEFENDS ITS SAFETY PROGRAM

COR received the following statement in response to an article based on a series that ran in the *Workers' Comp Executive* (see NEWS p. 00-6735):

"The August 18, 1997, issue of *Cal-OSHA Reporter* contained some information regarding the Los Angeles Department of Water and Power (LADWP) that is inaccurate. Specifically, statements that LADWP's safety staff is down to one person and people are getting hurt on the job due to downsizing are simply not true.

"LADWP has and will continue to place the highest priority on employee safety. This is evidenced by an average lost workday injury rate of 2.1, which as you reported is well below the public utility industry average of 5.7 days.

"This past July, as part of our ongoing reorganization to prepare for deregulation, we established a new Corporate Safety and Environmental Compliance Business Group (CSEC), reporting directly to the General Manager. Henri E. Cierpich, who was cited in your August 18, 1997, issue, is part of this new organization. CSEC is responsible for corporate safety policy, interfacing with regulatory agencies, performing facility safety audits, and providing an independent third party review of accident investigations. CSEC will track overall safety statistics, establish corporate-wide safety standards, and monitor individual business unit safety performance.

"Each business unit is accountable for its employees' safety, and will tailor individual programs to suit specific worker safety requirements. The details of a particular business unit's safety program, including which elements are implemented and which receive the greatest emphasis, are decisions left to the business unit.

"As we prepare for a deregulated environment, we want to keep in mind that our employees are our most important asset and no job is so important that we cannot take the time to do it safely.

"(Signed) Michael A. Reavis, Director of Corporate Safety and Environmental Compliance."

SOME SOLUTIONS FOR ACHING BACKS

NURSING HOME METHODS: Because of large numbers of back injuries, nursing homes are ranked high on the list of high hazard industries. A pilot project at a nursing home in the San Francisco area has greatly reduced the number of back injuries among nursing aides. UCLA's Labor Occupational Safety and Health Program (LOSH) and the Vale Health Care Center in San Pablo began to work together a year ago for injury prevention. Their goal was to help aides learn how to lift or move patients in back-friendly ways.

At Vale, there were about 10 back injuries every year among the 70 aides. LOSH put nursing aides through two injury-prevention training sessions that lasted 3-1/2 hours each. A labor-management committee was set up to review injury problems. And Vale replaced some of its old, awkward patient lifting systems with two electrically powered $4,000 machines that were easier to use.

Valerie Paynter, Vale's staff director, said the new equipment already appears to have paid for itself. She told the *Los Angeles Times* the company's workers' compensation expenses from

IN THIS ISSUE

FILING INSTRUCTIONS: File pages 00-6749 to -6752 behind page 00-6748 following the NEWS tab. File Digest pages 40-3381 to -3382 behind page 40-3380 following the DECISIONS tab.

patient-handling incidents totaled nearly $30,000 over 1995 and 1996. So far, there has been only one back injury this year, and it happened to a worker who wasn't using one of the new lifts.

Vale plans to buy two more of the new lifts. GranCare, Inc., its parent company, is beginning similar programs at two of its other Bay Area nursing homes.

Project director for LOSH is Diane Factor. The key, she said, is support from both workers and management.

BACK BELTS FOR HOME HEALTH CARE WORKERS. The Southern California Injury Prevention Research Center hit the national scene last year with its study of Home Depot employees' back belt use. Injuries were reduced by 34 percent over six years, with the greatest effect observed on employees classified as heavy lifters.

The center is now doing another back belt study, this one in New York with 32,000 home health care workers. This is a large prospective controlled study. Once there are some results, Dr. David McArthur promised to share them with *COR*.

BACK SCHOOL WAS A BUMMER
FOR POSTAL EMPLOYEES

Back care classes that offer instruction in proper lifting techniques and exercises for strengthening back muscles are often recommended to reduce injuries. Researchers at Brigham and Woman's Hospital in Boston led by Lawren H. Daltroy wanted to test the efficacy of the approach. They set up a back school for postal workers at two large mail processing centers. Therapists put on two three-hour training sessions for small groups of mail handlers, clerks and supervisors. They all got three or four refresher courses over three years.

In all, 2,668 employees went to back school. A similar number of untrained workers were followed for the same period. During 5-1/2 years of follow-up, 36 workers suffered back injuries but there was no significant difference between those who got the training and those who did not. The number of lost workdays and the cost of the injuries was the same.

"I think (back schools) can be very useful for mini-aid people who already have back pain, but not as blanket training for everybody at a work site," Daltroy said. "Our money can be better spent doing other things," such as redesigning workplaces and making it easier for workers to return by giving them less strenuous light duty jobs until they heal.

The results of the study appeared in the July 31 issue of the *New England Journal of Medicine*. The text of the article is available for $10 by calling 800-843-6356.

Cal-OSH STANDARDS BOARD'S AUGUST MEETING

The August 21 public meeting and hearing of the Cal-OSH Standards Board was brief, *COR* was told. The board first heard public comments about changes proposed for two sets of Construction and General Industry safety orders.

ERECTION OF STRUCTURES

Four sub-subsections of §1710(g) were modified to clarify that references to working and traveling on the skeleton steel of multi-story buildings will apply only to ironworkers, not other employees. The Division of Occupational Safety and Health (DOSH) requested the change after a carpenter at a Lusardi Construction Company site fell 24 feet to his death.

Construction §1670(a) requires personal fall protection for employees exposed to a fall of more than 15 feet, and DOSH cited under that subsection. Lusardi argued that all employees working and traveling along skeleton steel—not just steel workers—were subject to the 30-foot requirements of §1710(h). The employer contested the citation all the way to district court level, unsuccessfully. DOSH hopes the change will clear up any confusion.

Steven Cooper, Ironworkers International, spoke in favor of the change. He offered some other suggestions, but was told they were outside the scope of §1710(g). Chairman Jere Ingram suggested that he submit a petition.

REBAR. By letter, Safety Director Herb Higgins of Regional Steel Corporation in Claremont, CA, said he was a rebar

Cal-OSHA Reporter™

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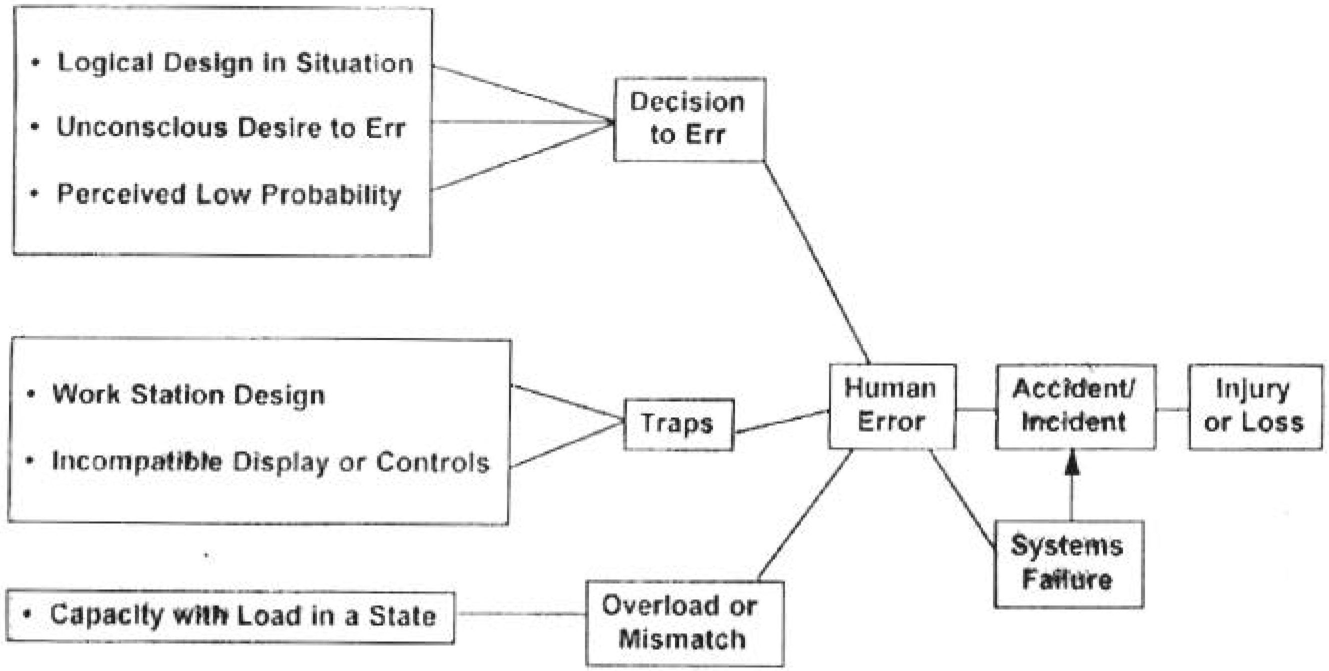
ACCIDENT/INCIDENT CAUSATION MODEL

Figure 9



Dan Petersen, Human Error Reduction, 1981

PHASE PROCESS IN UNDERSTANDING THE CONTROL OF OCCUPATIONAL INJURIES & ILLNESS
HOPWOOD - 12/93

PHASE I (REC)	PHASE II (EMP)	PHASE III (PAT)	PHASE IV APPLICATION & TEST
RECOGNITION (Existence) • observation • scientific study • experience • anecdotal • legislative EVALUATION (Magnitude) • sample • measure • costs • #/frequency CONTROL (Reduction/Maintenance) • Physical • Administrative • Training (& Education)	EQUIPMENT • selection • use • maintenance MATERIAL • selection • use • maintenance PEOPLE • selection • use • training	PHYSICAL • separation • distance • shielding • process ADMINISTRATIVE* • rotation • time TRAINING/EDUCATION* • training • education	

* These two have a down side - they do not change the hazard

Figure 10

THE USE OF THE AIR BELT™ IN INDUSTRY

Safeguard Technologies
October 1994

Seven years + Sixteen million belts = Confusion

FACT: people are applying many different back belt products in many different ways, with very different results. The answers to how well they work, are all different, too

A recent Back Belt survey in various sectors of the economy shows from the 300 respondent companies that

- 65% supply back belts
- 42 % of those who supply belts have a program
- 75 % of those with a program report a reduction in back claims

The survey also shows why we are confused:

- 35 % do not supply back belts
- 58% of those who supply belts don't have a program
- 25% of those with a program do not have positive results

NIOSH POSITION BULLETIN

Industry has expressed much concern over the memo of August 5, 1994. It is not all bad news, many of their comments make sense. For example, who would argue with their statement "The most effective way to prevent back injury is to redesign the work environment and work tasks to reduce the hazards of lifting." However, is that position always attainable, practical, cost effective? What about workers who hurt their backs by sports injury or tasks unrelated to lifting? Many of the naysayers of back belts admit the use of back supports seems to benefit this group. These are the individuals who, frankly, account for most of the costs associated with back injury.

The confusion seems to be focused on the effectiveness of belts by healthy workers. Interestingly, many of the corporations who claim successful Back Injury Prevention Programs, use back supports. Reference to the statistics noted above for the three hundred companies.

CONCERNS FROM RESEARCHERS

There seems to be an apparent lapse of consistent application of criteria when reviewing research. Bias becomes quickly evident. We must evaluate information carefully, perhaps seeking assistance when attempting to understand data and conclusions. In a recent summary of papers reviewing positive and negative studies on back supports, the reviewer notes that he did not include many studies in his paper because they had no matched control group, no post-trial sample size, etc. Yet, in the clinical trials cited, virtually none of these criteria are met.

And, unfortunately, there was no scrutiny of practical issues, such as the appropriateness of a wide, stiff belt used in the 42 inch belly of an airplane to load luggage. The researcher in that study indicates 58% of the workers discontinued wearing the belt prior to the end of the project. We constantly hear this study cited as a case against back supports. Shouldn't the conclusion be that certain styles of belts are not appropriate in certain situations. Training should include a choice of belt to use. Isn't that true of hearing protectors, safety shoes, and respirators.

The reasons people have for not using back belts do not apply to using the Air Belt™

- ***Back belts weaken muscles.***

The Air Belt™ does not weaken muscles, it does not reduce any range of motion or do the normal work of back muscles.

- ***Back belts only remind the user to lift properly.***

Lifting properly or working smarter is a function of training. Reminding is a positive reinforcement of training. Safety products do remind, but valued products have their own functionality. The Air Belt™ helps to eliminate unwanted lower back contractions. This will reduce fatigue and residual back pain that will occur if unwanted contractions from work go unchecked. The Air Belt™ helps maintain proper posture by placing pressure on shortened muscles, allowing them to return to their normal resting length to promote proper spinal alignment. This alignment is often expressed as keeping your head and shoulders over your hips. This alignment should be stressed when lifting, standing or even when you are seated.

- ***Back belts cause a false sense of security.***

The need for ongoing training and understanding of the product cannot be overstated. ***Safeguard Technologies*** can assist you by providing training aides, fitting belts, addressing safety and ergonomic committee meetings.

For example, hard hats can't really prevent many injuries by themselves. A ***"Hard Hat Area"*** program prevents tools and material from falling, makes head height obstacles avoidable, and prominently displays signs to alert potential danger and remind people to follow the rules. A ***"Hard Hat"*** alone does not prevent head injuries, as well as when a comprehensive program is implemented.

If you agree the *cost of preventing* a back injury is less than the *cost of a back injury*, then this is what you need to do:

Make a commitment to participate and contribute to a program that takes action to reduce back injuries.

Set up an effective safety program with effective safety products for predictable positive results.

Don't Compromise - if either the product or the program is compromised, the results are compromised.

A back injury prevention program in combination with the Air Belt™ back supports has been shown to produce better results than either approach utilized separately.

The program approach is very important, it can reduce back injuries by making the work place more ergonomically correct, and the worker work smarter. The Air Belt™ is very important, it can reduce and help prevent lower back pain that is caused by some types of work.

THE PROGRAM AND THE AIR BELT™ PREVENTS BACK INJURIES

Commitment

A pro-active commitment to reducing back related injuries is the most important element of a successful program. A Win/Win decision. This commitment must start at the top of the company organization and must be transmitted to every employee.

Identification

Identify the kind of job that often contributes to lower back injury. Identify tasks where frequency, bulk and weight exceed NIOSH targets. Identify individuals who have suffered a previous back injury, they are four times more likely to re-injure themselves than those who have not had a previous back problem.

Availability

Make Air Belts™ available to those individuals who would like to use them. Allow individuals to choose between 2 or more Air Belt™ models so their personal needs are met, and their "buy-in" to the program is present.

Training

People need to know how the Air Belt™ can lessen the risk of back injury by reducing unwanted muscle contraction. By reducing unwanted muscle hypertonicity, Air Belt™ can help maintain the lordotic curve of the lower back, desirable in lifting and seated postures. They need to know the Air Belt™ will not weaken muscles, because it does not deny range of motion or do the work of the muscle groups. And, it won't help anyone do anything extraordinary. Each belt has a warning label indicating this fact. Safeguard's training video also reinforces this message. Sessions on safe lifting techniques, physical conditioning, and the benefits of good posture are all part of ongoing training.

Ergonomic Evaluation

Establish a task force, develop action plan, analyze work site and work practices, assess employee capabilities, define possible changes, prioritize actions, and measure results. The evaluation should involve the input of all employees.

Medical Surveillance

Individual physical capabilities should be determined to establish if they are able to perform specific tasks over the expected duration.

The following reference information may be helpful; most are specific to our patented pneumatic back belt products:

Your safety products sales representative can send any of the following studies

"AirBelt, Initial Clinical Experience". Prevention of Reoccurrence of Back Injury in High Risk Group of Workers", Peter R. Sebastian, D.O., board certified neurologist

Rehabilitation Study, "Acute and Chronic Effects of Pneumatic Lumbar Support on Muscular Strength, Flexibility, and Functional Impairment Index", which demonstrates effectiveness of Air Belt^{TM} in treating back injury, Keith W. Penrose, Ph.D., Kumkay Chook, MD., John L. Stump, DC., and MS Sports Medicine

"Effects of Lumbar Belts on Trunk Muscle Strength and Endurance", compared daily use of soft, flexible belt versus traditional weight lifters belt in construction industry, Eve Holmstrom and Ulrich Moritz, Department of Physical Therapy, University of Lund, Sweden

"Back Injury Prevention Pilot Program, Philadelphia Electric Company", report summary covers 472 workers who were evaluated by control group, training only, Air Belts^{TM} only, training and Air Belts^{TM}, the later achieving both decreases in severity and frequency of back injury, John F. McLaverty CIH, CSP

"Muscles, central nervous motor regulation and back problems", specific pages of this report indicate the desirability of relaxing tightened back muscles before attempting to use or strenghthen abdominal muscles, Dr. Vladimir Janda

"Clinical Anatomy of the Lumbar Spine", downward direction of the action of the back muscles as they contract exert a longitudinal compression of the lumbar vertebral column. The Air Belt^{TM} works to decrease the electrical activity of these muscles, therefore being a more likely protector of axial compression loads, Bogduk and Twomey

"The Minimum Abdominal Belt Aided Lifting Weight", statistically significant differences were found in the measurement of erector spinal and external oblique integrated EMG's, moment impulses, and low back force impulses, the Air Belt^{TM} providing the best results for these parameters during the critical phases of lifting, Thomas Hilgen, Masters Thesis, Auburn University

Back Belt Market Analysis and Report available from:
John Alden Associates, P.O. Box 51, Holden, MA 01520
(508) 853-1858
(estimated cost $220)

In addition to the studies listed, letters from professional sports team athletic trainers, and testimonials from industrial safety managers are available

We can arrange for your doctor or therapist to talk with a peer who has experience with Air Belt™ products.

The most compelling information is not from studies

It is from someone you know

Someone who knows the Air Belt™ works for them

Starting a Program

We can work with you to establish a pilot program. The pilot requires the essential elements of a Back Belt Program for reasonable evaluation. The pilot should target the type of work that seems to contribute to back pain.

We can provide the appropriate sample of Air Belt™ products, or any of our other comfortable hand, wrist, elbow, foot, ankle, knee, and body protective products for your considerate evaluation.

Air Belt™ and Air Flex™ are registered trademarks of :

Safeguard Technologies
1-800-Air-Belt

NASSCO Employee Ergonomics Profile

About Your Personal Ergonomic Profile

Ergonomics is about how you relate to your physical work area - both on the job and at home. Proper ergon[illegible] design fits the job to the person, instead of the other way around. Employee compatibility with their work env[illegible] helps to minimize fatigue, stress and musculoskeletal injury (involving the muscles and supporting structures [illegible] body). Part of NASSCO's ergonomic study involves evaluating your response to the following questionnaire. Y[illegible] response is important in helping us identify problem areas relating to your work area.

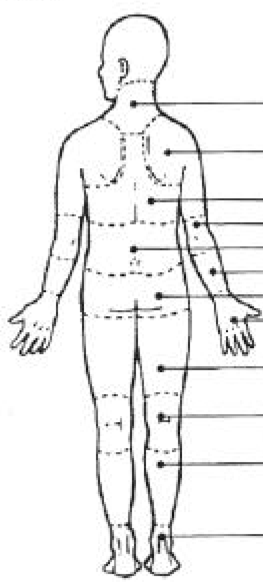
General Information

Your Name	Badge #	Work Class	Phone
Dept. Name	Dept. #	Your Work Group	Bldg. #
Dept. Mgr.	Your Supervisor	Mail Stop	Phone
Brief Description Of Your Work Activities			
Office Equipment That You Use & Average Daily Time That You Use It			
Do You Have A Muscloskeletal Disorder Incurred At NASSCO, A Previous Employer, Or At Home? ☐ No, ☐ Yes **If Yes, Please Explain:**			

Employee Musculoskeletal Assessment

Do you experience discomfort, numbness, or pain in any part of your body at work or at home? For those body parts affected, indicate how often and how much (typically).

For any areas of discomfort, please mark **how often** AND **how much.**



	how often: never	rarely	sometimes	often	always	how much: mild	moderate	severe
Neck	○	○	○	○	○	○	○	○
Shoulder	○	○	○	○	○	○	○	○
Upper Back	○	○	○	○	○	○	○	○
Elbow	○	○	○	○	○	○	○	○
Lower Back	○	○	○	○	○	○	○	○
Forearm	○	○	○	○	○	○	○	○
Hip	○	○	○	○	○	○	○	○
Wrist/Hand	○	○	○	○	○	○	○	○
Thigh	○	○	○	○	○	○	○	○
Knee	○	○	○	○	○	○	○	○
Lower Leg	○	○	○	○	○	○	○	○
Ankle/Foot	○	○	○	○	○	○	○	○

Work Station Evaluation: Based on your experience, how often do you...

	never	rarely	sometimes	often	always
1. Need to make long reaches:					
• with your arms to get items you need?	☐	☐	☐	☐	☐
• with your legs (e.g., to reach foot pedals)?	☐	☐	☐	☐	☐
Explain: ______					
2. Work at surface heights that are uncomfortable for you (e.g., low or high desks, counter tops, file cabinets)?	☐	☐	☐	☐	☐
Explain: ______					
3. Make motions that involve forceful effort:					
• with you hands (e.g., grasping, twisting)?	☐	☐	☐	☐	☐
• with your arms (e.g., pushing, pulling)?	☐	☐	☐	☐	☐
• with your back (e.g., lifting, pushing, tugging)?	☐	☐	☐	☐	☐
Explain: ______					
4. Work in positions requiring:					
• bent or twisted wrists (e.g.,keyboard work)?	☐	☐	☐	☐	☐
• elbows held away from the sides of your body?	☐	☐	☐	☐	☐
• bent or twisted back (e.g., working at low surfaces)?	☐	☐	☐	☐	☐
• bent neck (e.g., holding phone, looking at documents)?	☐	☐	☐	☐	☐
Explain: ______					
5. Do any activities that require repetitive:					
• hand and wrist motion (e.g., keyboard, mouse, other)?	☐	☐	☐	☐	☐
• arm and shoulder motions (e.g., filing, lifting)?	☐	☐	☐	☐	☐
• lower back motions (e.g., lifting, bending over)?	☐	☐	☐	☐	☐
Explain: ______					
6. Have to maintain a steady position to the point where fingers, arms, etc. are strained? **Explain:** ______	☐	☐	☐	☐	☐
7. Work in a physical area with:					
• poor lighting (e.g., too bright, too dim, excessive glare)?	☐	☐	☐	☐	☐
• temperature extremes (too hot or too cold)?	☐	☐	☐	☐	☐
• background noise that prevents easy communications?	☐	☐	☐	☐	☐
Explain: ______					

Do you have a physical disability that you feel requires a work station modification? ☐ No ☐ Yes

Explain: ______

Last Form Update January 12, 1995

DELIVERABLE G

IMPLEMENTATION OF BEHAVIOR BASED SAFETY PROCESS IN ASSEMBLY AREA

NATIONAL SHIPBUILDING RESEARCH PROGRAM

PANEL SP-8

PROJECT 8-96-3

DELIVERABLE G

IMPLEMENTATION OF BEHAVIOR BASED SAFETY PROCESS IN ASSEMBLY AREA

SUBMITTED BY

NATIONAL STEEL AND SHIPBUILDING COMPANY

TOM FAWCETT
PROJECT MANAGER

FREDDIE HOGAN
PROJECT ENGINEER

TABLE OF CONTENTS

SECTION I

Development of a Behavior-Based Injury Prevention Program

Each year medical claims and lost time injuries as a result of on-the- job accidents cost American companies millions of dollars. Most companies have implemented numerous diversified safety training programs and policies in an attempt to reduce the number of accident related injuries. The focus of many of these programs has been global in nature, and their effectiveness is difficult to monitor and measure. Results of evaluations of conducted among health and safety training practitioners indicate that it is generally not possible to determine if health and safety training are effective (Vojtecky & Schmitz, 1986.)

The problem is contemporary safety programs focus primarily on generic safety concerns without concentrating on specific areas of consideration and individual tasks performed by workers. Improvements in equipment, tools and personal protection gear may be one solution to the problem of escalating injury related expenses. Alternatively, implementation of training specifically designed to minimize at-risk behavior in areas where such behavior is most prevalent may be beneficial.

The industrial manufacturing and heavy industry working environment is not inherently safe; therefore safety precautions are essential. Components of a complete safety program include worker attitudes and skills, protective equipment, tools, workplace written policy, safety committee or department, and safety training. Safety training alone does not constitute a complete safety program; however, safety training is a critical element affecting other components, and in order for a safety program to be effective, all elements of the safety program must be in place. This report focuses on the development of a behavior-based safety process designed to identify at-risk behaviors and prevent injuries.

Background

The Rand Institute in Washington D.C. estimates costs associated with on-the-job accident-related injuries to be $82 billion per year (Saccaro, 1994, p.13). Although the costs attributed to Occupational Safety and Health Administration (OSHA) fines have increased, they are an insignificant portion of the total cost of accidents to American industry. Accident related injuries have many sources, and the total cost of these injuries is often difficult to realize. Costs associated with worker's compensation, worker morale, and medical/lost time claims all contribute to the total cost of accident-related injuries.

Workers' compensation is the government-mandated insurance program that provides reimbursement to injured workers. Costs associated with worker's compensation are the leading reason for businesses to move out of the U.S. (Saccaro, 1994). However, worker's compensation costs are only a small part of the true costs of accident-related injuries to a company. Other costs such as reduced productivity, training and salaries for replacement

workers, possible lawsuits, and decreased morale also exist and are difficult to quantify. The effect of accidents and injuries on worker morale is perhaps the most difficult cost to accurately measure. When a worker's attitude is changed because of an on-the-job injury, the cost to a company is impossible to gauge. This cost is multiplied by the effect such negative attitude has on the morale of co-workers.

Corporate safety programs

Corporate America in general and shipyards specifically do not have to accept injuries as inevitable because of accidents in the workplace. A combination of regulatory impact, business incentives, and labor incentives have stimulated implementation of safety programs over the past two decades. The U.S. Bureau of Labor Statistics reports that since 1978 the number of fatalities per 100,000 full-time workers has decreased by 50 percent, from 9.8 to 4.3 (Saccaro, 1994, pg.21) thus indicating that occupational safety programs and training do work. Presently the U.S. is faced with the challenge to prove that we can operate as efficiently as other nations where worker safety and health are emphasized as highly. With the support of government, unions, and insurance companies, enlightened management understands the true costs of doing business and has the opportunity to make the correct ethical decision with respect to worker safety.

To prevent accident-related injuries, corporate safety programs must focus on both the workforce and the workplace. Successful safety programs integrate the fundamentals of safe conditions and safe behaviors. Safety practitioners often refer to the "safety hierarchy" in their approach to accident prevention. The safety hierarchy is not the result of a research base, but is a product of the experience of safety professionals and organizations, and can be represented as follows (Barnett & Brickman, 1986):

1st priority:	Eliminate hazard or risk
2nd priority:	Apply safe-guarding technology
3rd priority:	Use warning signs
4th priority:	Train and instruct
5th priority:	Prescribe personal protection

The safety hierarchy described herein is generally used as a rule of thumb because not all the approaches listed are feasible for all circumstances. improvements in corporate safety are generally categorized into the following five groups:

1. *Behavior-Based Training* -- An organizational development model that uses training and implementation to identify behavior, measure performance, give feedback, and identify new behavior (Krause, Hidley, & Hodson, 1990).

2. *Ergonomic* (equipment and body position) -- An approach to safety which deals with the science of the problems related to fitting a man's anatomical, physiological,

and psychological characteristics in such a way as to enhance human efficiency as well being (Taber's Medical Dictionary).

3. *Managerial* -- Includes safety and safety training as a part of your business. Takes into consideration product quality, schedule efficiency, and production costs, and how these aspects can be improved by proper safety training. Effectively manages all aspects of injuries including lost time, worker's compensation, and medical claims.

4. *TQM* (Team based) -- The formation, organization and effective use of process improvement teams to analyze specific safety concerns, and suggest solutions and plans for implementation. A healthy workplace is likely to be a quality workplace. Many companies have initiated quality management programs, and safety is an important component in any quality program. A safe working environment contributes to the attitudes and behaviors that lead to quality goods and services. Methods that are commonly used to improve quality can also be applied to improve safety as well (Saccaro, 1994).

5. *Environment* -- A safety program which makes improvements to the physical conditions of the workplace including housekeeping, engineering controls, and other methods to remove unsafe conditions.

The "safety hierarchy" and general safety categories outlined do not always represent a single-measure approach. Often, two or more elements of accident prevention must be implemented to reduce injuries. The decision to take an active role in the prevention of injuries by monitoring safety and reducing hazards is an important first step, however selection of the proper safety program is the key element to success (Barnett, & Brickman, 1986).

Selecting An Effective Safety Program: A Case For Behavior-Based Training

Although safety awareness may eliminate some of the hazards faced by workers, safety awareness alone cannot eliminate all risk in the workplace. Effective techniques must be used to influence employees to avoid unsafe behavior. Peters (1991, p.53) outlined several strategies for encouraging employee self-protection such as: incentives, disciplinary actions, fear messages, and behavior modeling. However, because of issues concerning cost, resources, effectiveness, and attitudes, Peters (1991, p.69) states that most managers are unclear as to which of the strategies to implement.

The use of behavioral modeling through observation and feedback techniques has been shown to be an effective approach to safety. Chhokar and Wallin (1984) studied the behavioral safety performance of employees in an industrial plant by use of an observation instrument. The instrument included 35

specifically identified key behaviors, and the applied behavior package consisted of training, goal setting, and feedback. The results of the study confirmed the applicability of a behavior-based approach to safety. The approach suggested by Chhokar and Wallin (1984) identified specific behaviors that represent the safe way to perform required tasks, trained employees in these methods, and used periodic monitoring and feedback to enhance safety. Significant levels of improvement were reached only when training was combined with feedback. They concluded that a behavior-based approach seemed to be an effective alternative to the use of disciplinary actions, incentives, or fear messages.

<u>The role of behavior observation, feedback and intervention</u>

Cohen and Jensen (1984) used a behavior-sampling approach to develop and evaluate a safety training program focused on reducing unsafe conditions associated with lift truck operators in a warehouse. The study concluded that a well designed and administered occupational safety training program, emphasizing safe work practices derived from a true assessment of need, can be effective in improving on-the-job behavior. The study also showed enduring positive effects of the training program and indicated that these effects can be attributed to changes in work habits due to continued practice in safe work procedures.

Additionally, the use of performance feedback is a simple, effective, and durable method for promoting safety in other industries. For example, Fellner and Sulzer-Arnold (1984) studied the effects of posted feedback for improving safety in a paper mill. The posted feedback reflected safe and unsafe practices and conditions common to the workers employed at the mill. Also, injury and accident data were posted monthly. The study found that human motivation based on antecedents and consequences, such as performance feedback, is an effective way to reduce accident related injuries.

Behavioral observation and feedback alone are often not enough to enhance safety; a complete safety training program must also include some form of intervention. A study done at a shipyard in Helsinki, Finland showed a decrease of 20 percent in accident-related injuries by use of an intervention program. Thirteen small groups with a total of 97 members were employed in the intervention program focused on enhancing safety by improving housekeeping. The groups used training, frequent monitoring, and feedback of results, all elements of behavior modification technique. The departments that noticed the largest improvement were those departments in which the small groups worked actively and succeeded in involving other personnel in the program (Saarela, 1990).

Additionally, another study of an intervention program at the same shipyard in Helsinki, Finland in 1984 used a poster campaign as a means of intervention to reduce the number of injuries associated with the use of scaffolds (Saarela, 1989). The objective of the study was to determine if the safety consciousness among workers

could be enhanced by negative feedback. The focus of such campaigns is on the cognitive processes and motivation, and the influence they have on workers. The campaign seemed to have been effective in assisting workers to identify and control hazards by raising their hazard consciousness. However, other studies have shown that informational safety campaigns alone are seldom strong enough to lead to outstanding improvements in safety (Colver, Hutchinson & Judsen, 1982).

Safety Training Program

The ultimate goal of any safety training program is to create an environment in which workers are neither injured nor made ill by the work they perform. Competent workers are those workers possessing skills, attitudes, and knowledge to perform their work properly; these workers are likely to be safe workers. Competency training should be considered an important part of a safety training program. A comprehensive safety training program affects both the worker (skills, attitudes, and knowledge) and the workplace (administrative controls, engineering controls, workstation design, and protective equipment).

Management considers a training program that provides effective safety and health training a profit center. However, justifying the cost of safety training is an administrative, not a developmental concern; therefore, cost justification is not usually considered in the development of a safety training program. Industry generally accepts that examination of safety training on a cost-benefit analysis basis can easily justify implementation of a safety training program (Saccaro, 1994).

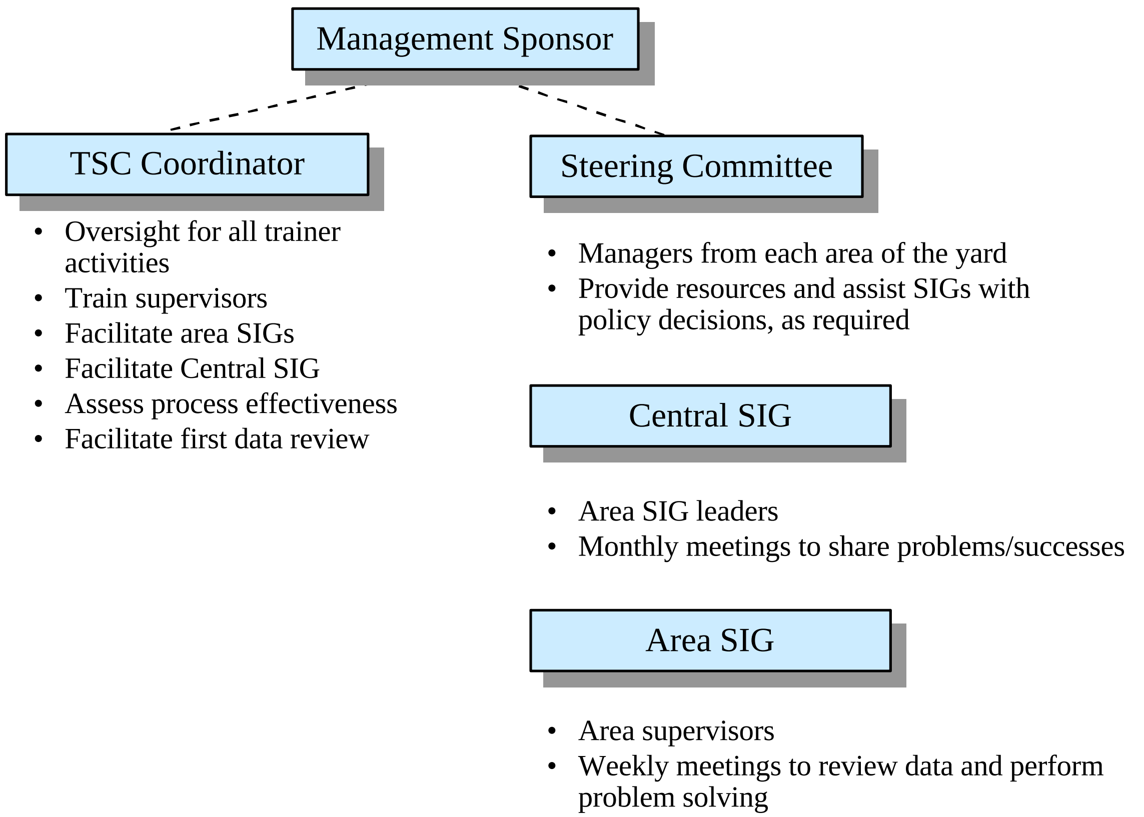
Although safety training programs may never result in a completely risk-free environment, a risk-free workplace is the rationale for the existence of safety training and is the goal toward which safety training is directed. If safety training programs cannot eliminate risk, they can go far to reduce risk. There is no justification for workers to leave the job at the end of the day physically injured, emotionally dysfunctional, or predisposed to illness.

SECTION Ic

NASSCO'S APPROACH

NASSCO has embraced the philosophies of Behavior Based Safety and adopted this model of organization change, calling our process, Total Safety Culture, or TSC. In order to provide the necessary support for any organizational change initiative, the proper infrastructure is essential. As groups complete their training and begin the observation and feedback process, a well-designed support system can provide the requisite resources and reinforcement vital to their continued success.

To achieve the Total Safety Culture change which has been undertaken at NASSCO, the following organizational support infrastructure was implemented:



Site Implementation Groups

Site Implementation Groups were created in each area of the yard as the TSC training reached their area. The SIG structure was very similar to a PIT team, in that the leader, recorder, scribe, timekeeper were selected in the group. The group itself is comprised of supervisors from that area who can serve as role models and TSC champions for their area. Each SIG meets weekly to assess their area's progress. Their review includes analyzing the data collected from the observation process, looking for trends and patterns, as well as taking action on at-risk items referred to them by the observing supervisors. The SIGs are also tasked with conveying information about the TSC observation process results to the supervisors for use at their 5-minute meetings or other venues as deemed appropriate. SIG leaders report individual area progress to the department manager/Steering Committee member on an on-going basis. Steering Committee members bring issues specific to their area to the Steering Committee as needed.

The SIGs are an integral part of the TSC process. As such, it is essential that they have the opportunity to learn from each

other. To accommodate that need, each SIG coordinator becomes a member of the Central SIG.

Central SIG

Area SIG Leaders meet monthly providing them an opportunity to learn from each other by sharing lessons learned and brainstorming suggestions for problem situations. The Central SIG serves as a clearinghouse for TSC best-practices throughout the yard, as well as providing a resource and support for each of the SIG members. The TSC Coordinator brings process or decision issues to the Steering committee for action and feedback.

Area SIG Sponsor

The Area SIG Sponsor is the department or area manager for each of the TSC areas. They provide on-going support and resources to their Area SIG. It is their responsibility to ensure on-going operational success of the TSC. They review, evaluate and approve recommendations from their Area SIG. They are members of the Steering Committee.

Steering Committee

The role of the Steering Committee in the TSC implementation is vital. They provide the managerial "clout" necessary to make needed policy and capital expenditure decisions that are beyond the scope of the Central SIG. The Steering Committee will report to the Management Sponsor.

Management Sponsors

The Management Sponsors are the Vice President of Production and Vice President of Finance. They will serve as champions for the yard-wide TSC process. The Steering Committee reports to them. They will provide necessary guidance and support for the Steering Committee, as well as serve as liaison with Executive Staff.

TSC Coordinator

The TSC Coordinator has overall responsibility for incorporation of the principles of behavior-based safety into NASSCO's culture. This responsibility will be implemented through facilitating the area SIGs, the Central SIG, and the Steering Committee. Additionally, the TSC Coordinator will have dotted line responsibility to the Management Sponsor. Additional Coordinator responsibilities include:

- Coordinating and implementing the strategic plan for TSC
- Developing training materials
- Delivering training to supervisors and employees
- Facilitating individual department's observation and feedback process
- Identifying additional training needed and working with Trades Training Coordinators to provide
- Monitoring the effectiveness of the ongoing training and implementation activities

The Coordinator position requires excellent communication, presentation and facilitation skills. Full knowledge of the principles of TSC, including behavioral psychology is essential, as well as the ability to make those concepts accessible by the supervisors and employees at NASSCO. Additionally, experience implementing cultural change initiatives is vital.

Training Roll-out

Training efforts began in the production areas of the yard, starting with the Assembly Area, the focus of this report.

SECTION IIA

Assembly Area Overview

The first area of the yard identified for implementation of TSC was the Assembly area. There are approximately 437 employees and 25 supervisors. Basically two trades function in this area, shipfitters and welders. The average number of years of service at NASSCO for supervisors is approximately 20. For hourly employees, the average is much less.

This is the area where A-2 units are assembled from pre-fabricated sub-units. The type of work activities performed in the Assembly area includes welding, burning, fitting, and grinding. The work is performed on “tables” or pin jigs of varying heights.

The supervisors play a key role in the success if TSC as they are the ones who conduct daily observations. The supervisor group as a whole in the Assembly area can be characterized as technically competent in their trade, but relatively unschooled in the art of management. As their years of service would indicate, resistance to change is high. Their management style could be described as “command and control.”

SECTION IIB

Site Implementation Group

A Site Implementation Group (SIG) was created from among the supervisors. One supervisor from each of the tables was selected to serve on the committee. As the Assembly area has a sizable second shift, the SIG group includes three representatives from the second shift.

This group is chartered with managing the success of the TSC process in the Assembly area. The SIG meets weekly, reviews the observation sheets, and identifies and completes action items as indicated on the observation sheets.

Communication from the SIG is extremely important. Among their responsibilities is the need to communicate SIG actions to the other supervisors, as well as, the employees.

In addition to attending supervisor training as outlined below, SIG members attended an additional 16 hours of training on their role as implementers of TSC for their area. Part

of this training included the creation of the observation sheet which would be used in the Assembly area observation and feedback process. The observation sheet in included in the Appendix section.

SECTION IIC

Training

Training for TSC was designed for two specific audiences -- supervisors and employees. The supervisor training consisted of two 8-hour days. These sessions were held on Saturdays in order to allow all supervisors for the area to attend at once and not compromise production. These classes provided an in-depth look at behavior based safety, the role of the supervisor in a "Total Safety" culture, and skill practice and feedback in the observation and feedback process -- the "heart" of the TSC process at NASSCO. Supervisor training was completed prior to starting the employee sessions.

Employee training consisted of a 3 1/2-hour overview. Employees were taken off the job for essentially a half day. Their class covered the concepts of Total Safety, the observation and feedback process and provided the opportunity to experience a mock video-taped observation. Both supervisor and employee courses included the use of a video tape discussing the art of giving and receiving one-on-one feedback. Course outlines for both the supervisor and employee training follow:

SUPERVISOR TRAINING

SESSION I — **<u>Total Safety Culture Overview</u>**

A. Define NASSCO's current safety culture

B. The elements of a Total Safety Culture

   1. The safety triangle
   2. Building safe habits

C. Understanding Motivation

D. Introduction to Observation and Feedback Process

E. Managing Change

SESSION II **<u>Observation and Feedback Training</u>**

A. Case Study using ABC model
B. SIG presentation of customized observation sheet
C. Video observation and feedback
D. "One-on-One" Video and feedback role play
E. Handling defensive attitudes
F. The Supervisors' Role in a Total Safety Culture

EMPLOYEE TRAINING

SESSION I **<u>Total Safety Culture Overview</u>**

A. Understand the elements of a Total Safety Culture
   1. The safety triangle
   2. Building safe habits
B. Understanding Motivation
C. Observation and Feedback Process
D. "One-on-One" Video
E. The employee's role in a Total Safety Culture

SECTION IID

The Observation and Feedback Process

The backbone of the TSC process is the observation and feedback process. As previously stated, due to Union contract restraints, only salaried supervisors are able to participate in the observation and feedback process. As stated in SECTION IIIB, the area Site Implementation Group (SIG) designed the observation process for the Assembly area. The Assembly Observation Sheet was then used in the supervisor training to allow them the opportunity to familiarize themselves with the sheets and their use.

In addition to the observation sheet, a definition sheet was created which expanded on each of the items listed on the observation sheet. The definition sheet was to be used as a resource and training tool prior to conducting the observations. Only the observation sheet itself was designed to be taken to the job site and used during an observation. A copy of the definition sheet is included in the Appendices.

The observation process began upon completion by all employees of their overview training. The intention was that no employee would be

approached by a supervisor wanting to conduct an observation without having attended training. There is a perception among employees that a safety observation is just another way for the supervisor to evaluate or "grade down" an employee. This was one of the major discussion points during the employee overview training. Therefore, the manner in which the supervisor conducts the observation and feedback session can reinforce or overcome that misunderstanding.

Initially, the goal was for each supervisor to conduct two 10-minute observations daily. The completed observations were to be dropped into a locked drop box to be picked up and tallied by someone outside the department. This information was then referred to the SIG group for action.

SECTION III OUTCOMES

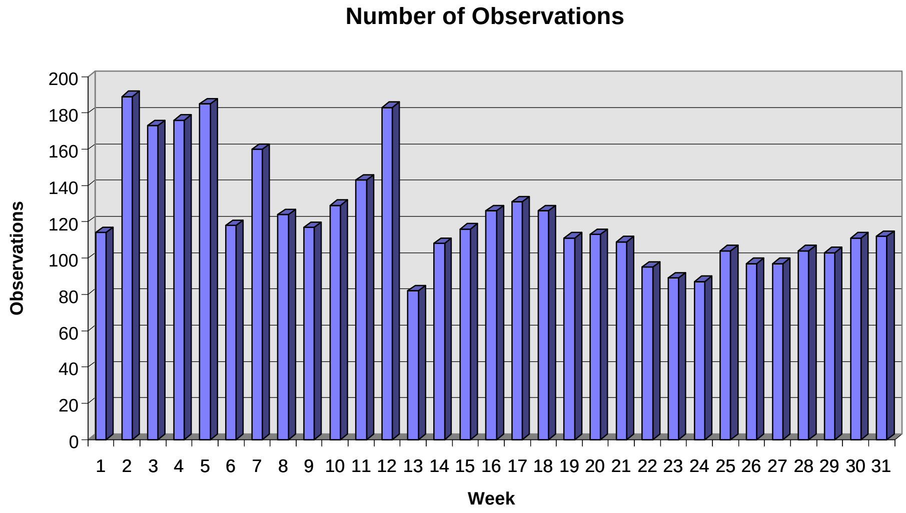
The Observation Process

The observation process began the first week in February, upon completion of both the supervisor and employee training. Initially, two 10-minute observations per day were required of all salaried supervisors. Compliance was slow and reluctant. Many supervisors did not perform the observations citing production demands. The SIG team tried to manage the process and conducted a problem solving session to determine the root causes of the lack of supervisor support for the TSC process with the following results:

- not enough time
- don't know how to fill out the sheet
- if they find at-risk conditions it just makes more work for them
- production schedules don't allow enough time
- it's just not a habit
- uncomfortable with paperwork in general
- observation sheet is too confusing

As a result of this brainstorming process, the SIG members started teaming up with other supervisors who were struggling with the observation process. This had a positive impact on the number and quality of observations being performed, for a while. It became apparent that the supervisors would perform better quality observations if they were asked to perform one observation daily, rather than two. In April the number of observations required was lowered to one a day. Many supervisors who were strong supporters of the TSC process continue to perform two observations daily.

The following chart shows the number of observations performed weekly since the beginning of the TSC process in the Assembly Area.



SECTION IIIB

SIG Actions

The SIG team was made up of supervisors representing the six different tables in the Assembly Area, plus three second shift representatives. As stated previously, the SIG team attended an additional 16 hours of training to understand their role and responsibilities in the TSC process. The team elected a leader, scribe and timekeeper.

The SIG team meets weekly for one hour. Their typical meeting agenda includes the following items:

- Review previous week's minutes
- Record action in open items
- Review the observation sheets
- Identify any new action items
- Discuss comments from observation sheets
- Problem solve issues that have come up in the previous week during production which may not be recorded on observation sheets

Each week, in addition to the observation sheets, the SIG reviews statistics which have been compiled from the previous week's sheets. Number of at-risk behaviors is tracked by line item on the observation sheets. The Pareto principle is used to identify "vital few" areas needing SIG attention. Sample SIG reports appear in the Appendix Section.

As the supervisors have struggled with completing the observation sheets, the SIG team has struggled with their role as managers of the TSC process. The area manager has had a difficult time letting go of control of issues which

should reside with the SIG; some SIG decisions have been reversed or second-guessed. As a result, the SIG team has been hesitant to make decisions and a feeling of inertia has developed.

In spite of these challenges, the SIG team has identified and resolved many safety action items. One of the first issues to be brought to the SIG's attention was ill-fitting safety glasses. The SIG team contacted several vendors who provided them with samples of different safety glasses. Groups of employees were brought in and tested for best fit. One type of glasses was selected for testing on one of the tables with the most eye injuries. The glasses were distributed to the employees who wore them for a period of two months. Data was collected using the following safety glasses checklist and a purchase decision was made as a result of the feedback.

BADGE	**NAME**	**FIT** Exc, Good, Poor	**SCRATCH?** Yes or No	**FOG UP** Yes or No	**COMMENTS**

SECTION IIIC

SUPERVISOR SURVEY

As part of their on-going management activities, the SIG team wished to determine the level of supervisor understanding and support for the TSC process. In August, a survey was conducted from among the supervisors with some surprising results. (Both survey and results are included in the Appendices.)

In brief, six months into the program, over 90% of the supervisors responding felt they had a good understanding of Total Safety Culture. When responding to a question of difficulty in performing daily observations, only 7.7% felt they had a hard time performing the desired number of observations. Additionally, almost 80% of the supervisors felt that employees were beginning to give each

other feedback about at-risk behaviors, one of the key elements of Total Safety Culture.

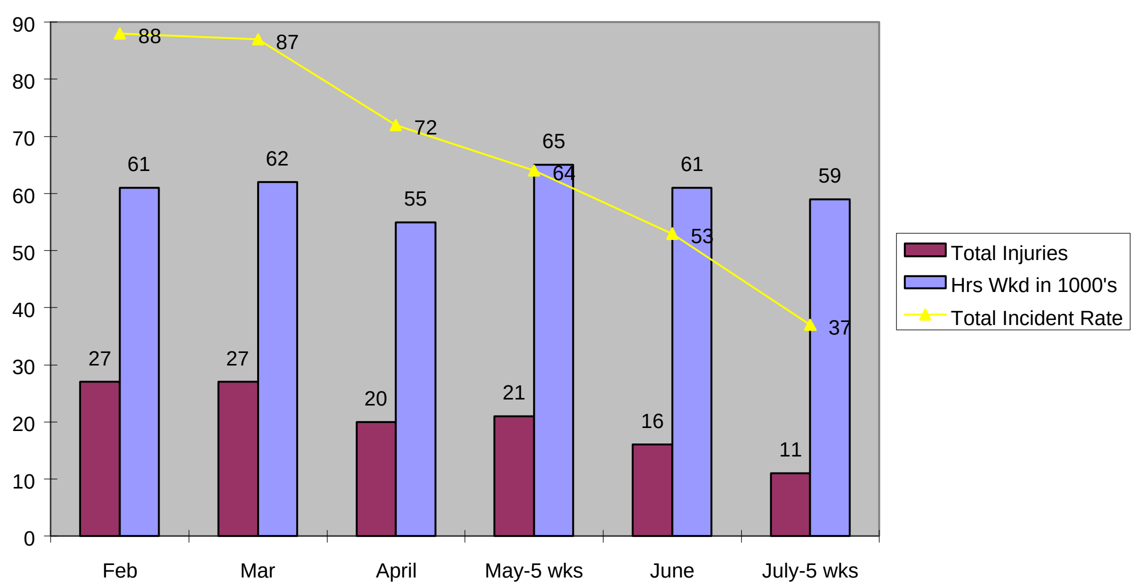
One key insight gained from the survey was that communication from the SIG team back to supervisors and employees was lacking. Several different remedies have been implemented, including wider distribution of the SIG minutes and more discussion of SIG actions at weekly safety meetings. This remains an area of concern for the SIG team.

SECTION IIIC

IMPACT ON SAFETY

A key measure of success for any behavior-based safety initiative is the reduction in the number of accidents occurring in the workplace. While the literature warns that little to no improvement should be expected for the period of 12-18 months after implementation, immediate improvement was seen in NASSCO's Assembly Area. Incident rates dropped from 88 in February of 1998 to 37 at the end of the six month period covered in this report. Chart follows:

STEEL ASSEMBLY INJURY SUMMARY 1998



Section IV

SUMMARY

The ultimate goal of any safety training program is to create an environment in which workers are neither injured nor made ill by the work they perform. A comprehensive safety training program affects both the worker (skills, attitudes, and knowledge) and the workplace (administrative controls, engineering controls, workstation design, and protective equipment.)

Although safety training programs may never result in a completely risk-free environment, a risk-free workplace is the rationale for the existence of safety training and is the goal toward which safety training is directed. If safety training programs cannot eliminate risk, they can go far to reduce risk. Behavior-Based Safety Training provides an organizational development model that uses training and implementation to identify behavior, measure performance, give feedback, and identify new behavior.

The use of behavioral modeling through observation and feedback techniques has been shown to be an effective approach to safety. Behavioral observation and feedback alone are often not enough to enhance safety; a complete safety training program must also include some form of intervention. The approach adopted by NASSCO identified specific behaviors that represent the safe way to perform required tasks, trained employees in these methods, and used periodic observation and feedback to encourage employees to perform the tasks in the prescribed safe manner. Significant levels of improvement can be reached only when training is combined with feedback.

In NASSCO's Assembly Area, a behavior-based safety program, Total Safety Culture, involved comprehensive training in theory and practice for both supervisors and employees. Supervisors conducted observations and provided feedback to employees. Data collected during the observation process was analyzed and acted on by a Site Implementation Group tasked with the responsibility of implementing TSC in their area. At the end of the first six-month period, incident rates had dropped by a significant percent.

As in any major organization change intervention, long-term change is slow in coming. While the safety statistics reflect a favorable trend, much work remains to be done in building relationships of trust between employees and supervisors, and between supervisors and their manager. The Total Safety Culture infrastructure is designed to empower supervisors to take appropriate actions to assure the success of the process, as well as empower employees to provide feedback to each other in regards to unsafe behaviors. These are two of the core elements of behavior-based safety and will continue to drive NASSCO's efforts in the future.

SECTION IV

APPENDICES

Assembly Area Observation Sheet

Assembly Area Definition Sheet

Sample SIG Reports

Supervisor Survey Report

❑ Observation Interrupted*

❑ SIG Follow-up

NASSCO ASSEMBLY OBSERVATION SHEET

Observer_____________________ Badge_______________

Area ☐ T-1 ☐ T-2 ☐ T-3 ☐ T-4 ☐ T-8 ☐ T-9 ☐ T-11 ☐ On Block ☐ Other___________

TC______Shift____Overtime Y N Date__________Time________

	Safe	At-Risk	NA	Comments
1.0 Housekeeping				
1.1 Trash, scrap, (slag) disposed				
1.2 Spills and water are cleaned up as appropriate				
1.3 Work area is properly organized				
1.4 Walkways are clear and unobstructed				
1.5 Lines, leads, hoses properly routed				
2.0 PPE (Proper PPE and in good condition)				
2.1 Eye and Face Protection				
2.2 Hand Protection				
2.3 Hearing Protection				
2.4 Hard hat				
2.5 Shoes and Clothing				
2.6 Respirators				
2.7 Other (knee pads, leathers)				
3.0 Body Use and Positioning				
3.1 Proper lifting techniques, gets help if needed				
3.2 Proper body mechanics used (proper position, stable footing, bends knees, stretches)				
3.3 Walking/Climbing				
3.4 Line of Fire/Pinch Points				
4.0 Environment				
4.1 Proper ventilation available				
4.2 Proper lighting				
4.3 Safe access and escape routes				
4.4 Emergency equipment available (fire bottles)				
4.5 Warning signs posted if required				
5.0 Tool Selection and Use				
5.1 All tools required for the job				
5.2 Proper certification for tools being used				
5.3 Tools used properly (including hook-up)				
5.4 Tools in good working condition				
5.5 Protection of tools/equipment				
6.0 Fall Protection				
6.1 Ladders (secured and used properly)				
6.2 Scaffolding (not altered, guardrails, toeboards)				
6.3 All holes guarded or covered				
6.4 Safety harness used when necessary				
6.5 Aluminum bolt-on 2 steps properly secured				

*Please explain in detail on the reverse of this form.

COMMENTS

After completing your observation & feedback, summarize the observation and feedback session below. Please clearly explain any SIG follow-up items AND explain why you interrupted the observation, if applicable. Comments about environment: wind, rain, hot temperatures, additional training needed, etc.

COACHING TIPS

Focus on the employee's Work Practice's
Focus on working safely, NOT on safety rules
Provide positive feedback FIRST
Offer corrective feedback NEXT
Express concern for employee's safety
Be respectful of employee
Raise issues, don't criticize
Don't argue
Talk with, not AT the employee
Use "at-risk" not "unsafe"

NASSCO ASSEMBLY OBSERVATION SHEET
DEFINITIONS

1.0 Housekeeping (Safety Manual Reference 3.7 CH#5)

1.1 Trash, scrap (slag) disposed of
- Hazardous material is in proper container and correctly identified

1.2 Spills and water are cleaned up as appropriate
- There are no oily or slippery substances on the floor
- Water is cleaned up appropriately for the work area

1.3 Material is properly organized
- Material is neatly stacked when not in use

1.4 Walkways are clear and identified
- Scaffold and staging are considered walkways

1.5 Lines, leads hoses properly routed
- Does not pose a trip hazard

2.0 PPE - Proper PPE and in good condition **(Section 4.2V.C CH#5)**

2.1 Eye and Face protection
- Only NASSCO approved Industrial Safety Glasses authorized
- Welding hoods, face shields to be worn properly and in good condition

2.2 Hand Protection **(Section 4.3.V.C CH#5)**
- Hand protection is appropriate to type of work
- Gloves are not to be worn when operating drills, punch presses, pedestal grinders, or other machines where the hand may be caught

2.3 Hearing Protection
- Hearing protection is worn in construction/assembly/shop areas
- Ear plugs are properly inserted in ears

2.4 Hard Hat
- Section 4.3 CH#5 notes where hard hats are mandatory or recommended
- Liner inserted in helmet correctly

2.5 Shoes and Clothing
- All leather shoes
- Heels at least 1/4 inch, no higher than 1-3/4 inch in height
- Long sleeves required while doing hot work
    - Clothing is not tattered
    - No cuffs on trousers

2.6 Respirators
- Employee is clean shaven
- Respirator is maintained in a clean condition
- Respirator is properly stored when not in use in a sealed plastic bag, not stored underneath tool bags or equipment

2.7 Other
- Knee pads used where advisable
- Leathers needed for overhead hot work

3.0 Body Use and Positioning (Section 3.2.II CH#5)

3.1 Proper lifting techniques used, gets help when needed
- Uses "power" grip to grasp objects
- Maintains a neutral or straight alignment of the wrists
- Bends at the knees and keeps back straight
- Holds objects close to their body
- Lifts with both legs and steps in direction of travel or load placement
- Does not turn or twist at the knees or lower back
- Gets help when the object is too heavy or too awkward for one person
- Does not carry heavy loads up or down ladders

3.2 Proper body mechanics used (proper positions, stable footing, bends knees, stretches)

3.3 Walking/Climbing
- Looks in direction they are walking and holds handrails when using stairs or ladders

NASSCO ASSEMBLY OBSERVATION SHEET
DEFINITIONS

3.4 Line of Fire/Pinch Points
- Avoids placing themselves between any moving equipment or under suspended loads
- Keeps hands and fingers away from areas where they can get caught between moving parts

4.0 Environment

4.1 Proper ventilation available and used correctly
- Size of vent hose is appropriate for the work being performed
- Exhaust ducting is attached directly to exhaust manifold
- Exhaust vent clear of debris and trash so as not to obstruct air flow
- 3 inch scoop used for arc welding, burning, or cutting when appropriate
- Employee keeps vent nozzle close to welding or burning operation

4.2 Proper lighting
- Area lighted so as to minimize shadows
- Temporary lighting sufficient and of correct type

4.3 Safe access and escape routes
- Employee knows escape route in the event of an emergency

4.4 Emergency equipment available (fire bottles)
- Ensure that a CO2 bottle is not being used in a confined space
- Employee knows location of nearest fire bottle station
- Employee knows how to use the fire bottle correctly

4.5 Warning signs posted if required
- Employee has taken appropriate action to protect themselves and others of hazardous conditions by posting signs, barricades and making appropriate notifications

5.0 Tool Selection and Use

5.1 All tools required per tradesmen's list
- Ensure tools listed on trades requirement trade list are available

5.2 Proper certification for tools being used
- Certification is valid for equipment being operated and still within the expiration date

5.3 Tools used properly (including hook up)
- All Chicago couplings have safety wire or clips
- Proper tool is being used for the task being done

5.4 Tools in good working condition
- Come-alongs have safety latch installed , hook not spread

5.5 Protection of tools/equipment
- Return to tool room when not being used for the job

6.0 Fall Protection (Section 3.1.II CH#5)

6.1 Ladders secured and used properly
- Ladder is not damaged
- Ladder is correct length for work involved
- Ladder is slanted at about a 75 degree angle (base is 1/4 of the ladder length from the wall)
- Stepladder is free standing and not tied off
- Employee is not standing or sitting on top two steps of ladder

6.2 Scaffolding (not altered, guardrails, toeboards)
- Guardrails, toeboards required when work area is more than 5 feet above the ground
- Erection, alteration and dismantling of scaffold must be performed by competent and qualified scaffold persons
- Top rail 42 inches high with a mid-rail half way between top and bottom rail

6.3 All holes guarded or covered
- Holes guarded, barricade in place
- If barricade is impractical then opening must be covered using a minimum of 3/4 inch plywood that is at least 10% larger than the opening

6.4 Safety harness used when necessary
- Harness is correctly worn by employee
- Harness is attached to a fixed point by use of a lanyard

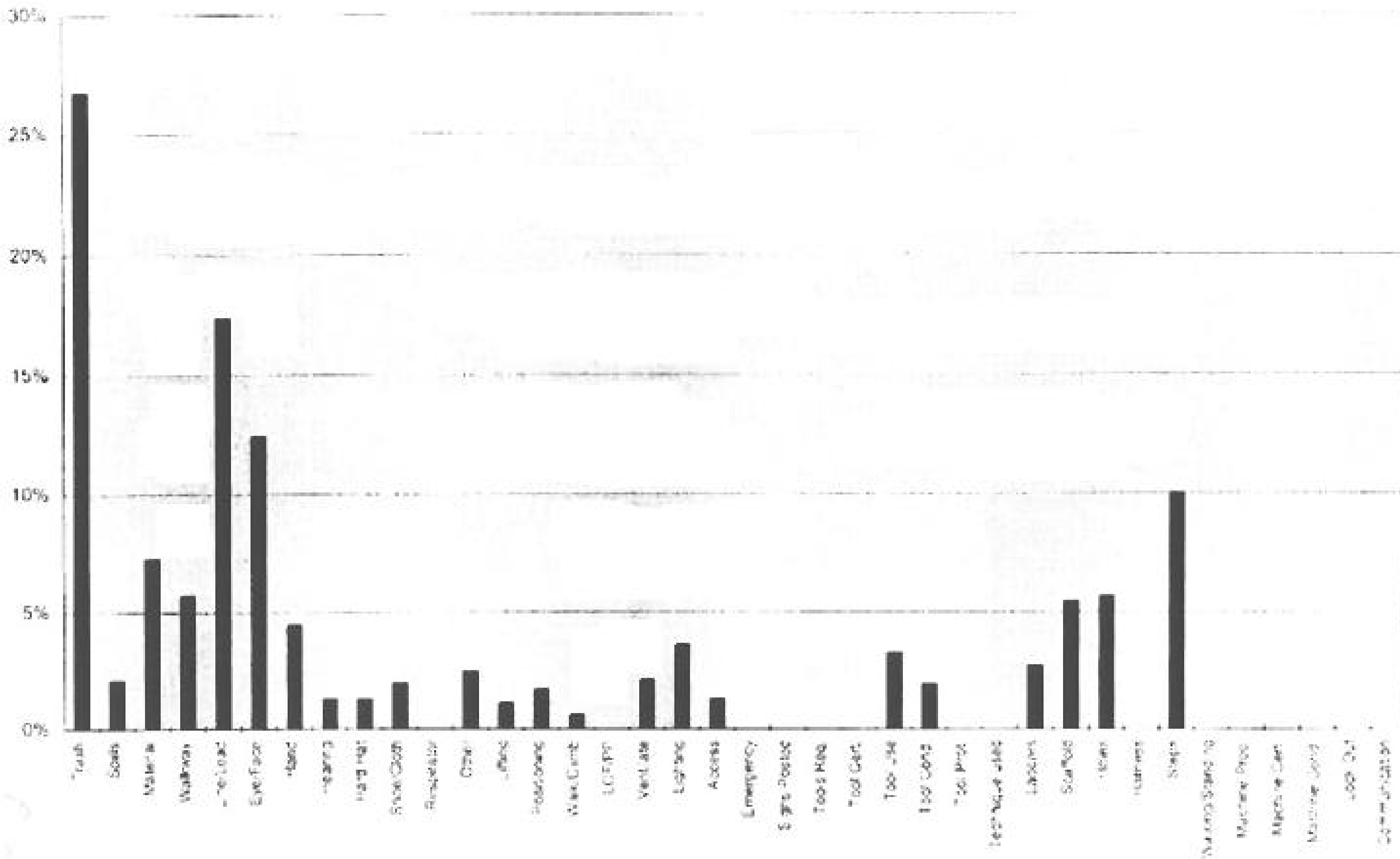
6.5 Aluminum bolt-on 2 steps properly secured
- Step is positioned properly and bolts tightened

ASSEMBLY DEPARTMENT

		Week # 28				Yearly Cumulative			
	Category	Safe	At-Risk	NA	% Risk	Safe	At-Risk	NA	% Risk
1.1	Trash	115	42	3	27%	2555	1198	46	24%
1.2	Spills	141	3	14	2%	3067	104	488	2%
1.3	Material	140	11	6	7%	3282	391	34	8%
1.4	Walkway	148	9	0	6%	3438	220	31	4%
1.5	Line/Lead	143	30	5	17%	2936	865	48	18%
2.1	Eye/Face	134	19	1	12%	3023	673	83	14%
2.2	Hand	150	7	0	4%	3572	117	11	2%
2.3	Hearing	151	2	0	1%	3573	87	9	2%
2.4	Hard Hat	154	2	0	1%	3642	15	8	0%
2.5	Shoe/Cloth	150	3	1	2%	3491	154	15	3%
2.6	Respirator	55	0	97	0%	1127	38	2518	1%
2.7	Other	120	3	32	2%	2505	211	934	4%
3.1	Lifting	175	2	10	1%	3763	23	397	0%
3.2	Positioning	174	3	1	2%	3860	41	32	1%
3.3	Walk/Climb	161	1	0	1%	3661	42	39	1%
3.4	LOF/PP	133	0	21	0%	2979	21	631	0%
4.1	Ventilate	98	2	56	2%	2021	34	1754	1%
4.2	Lighting	134	5	14	4%	2986	109	574	2%
4.3	Access	161	2	0	1%	3506	44	94	1%
4.4	Emergency	151	0	1	0%	3533	31	72	1%
4.5	Signs Posted	116	0	40	0%	2367	20	1244	0%
5.1	Tools Req.	154	0	0	0%	3624	21	20	0%
5.2	Tool Cert.	153	0	3	0%	3607	6	140	0%
5.3	Tool Use	149	5	1	3%	3544	71	40	1%
5.4	Tool Cond.	153	3	0	2%	3597	45	16	1%
5.5	Tool Prot.	154	0	0	0%	3580	14	45	0%
5.6	Technique used	0	0	0	#DIV/0!	48	1	1551	0%
6.1	Ladders	72	2	83	3%	1563	62	2058	1%
6.2	Scaffold	52	3	99	5%	1172	86	2380	2%
6.3	Holes	50	3	104	6%	1083	101	2467	2%
6.4	Harness	17	0	131	0%	375	20	3232	0%
6.5	Steps	27	3	127	10%	532	34	3061	1%
6.6	Walking/Standing	0	0	0	#DIV/0!	16	0	1601	0%
7.1	Machine Proc.	0	0	0	#DIV/0!	26	0	1591	0%
7.2	Machine Cert.	0	0	0	#DIV/0!	26	0	1591	0%
7.3	Machine Cond.	0	0	0	#DIV/0!	27	0	1590	0%
7.4	Lock Out	0	0	0	#DIV/0!	1	0	1616	0%
8.1	Communication	0	0	0	#DIV/0!	45	0	1573	0%
			165				4899		

Assembly Department
Week 28

% At-Risk



Assembly Supervisor Survey

Survey Title:
Assembly Supervisor TSC Survey

Administered To:
Assy Supervisor Survey
Aug 26, 1998

Assembly Supervisor Survey

Administered To: Assy Supervisor Survey | Date Administered: Aug 26, 1998

Main Report Section

1. I have a good understanding of the main ideas of Total Safety Culture.

n =	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
13	0.0	7.7	0.0	69.2	23.1
	Mean: 4.08/5	SD: 0.76	Mode: 4/5		

2. I believe that TSC, if done right, could improve safety at NASSCO.

n =	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
13	0.0	0.0	7.7	61.5	30.8
	Mean: 4.23/5	SD: 0.60	Mode: 4/5		

3. In fact, I think that TSC has improved our safety already.

n =	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
13	0.0	15.4	15.4	53.8	15.4
	Mean: 3.69/5	SD: 0.95	Mode: 4/5		

4. I have a hard time doing daily observations. (R)

n =	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
13	15.4	46.2	30.8	7.7	0.0
	Mean: 2.31/5	SD: 0.85	Mode: 2/5		

5. I enjoy doing the observations because I can talk to my employees about safety.

n =	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
13	7.7	15.4	38.5	30.8	7.7
	Mean: 3.15/5	SD: 1.07	Mode: 3/5		

6. I think the observation and feedback process has helped me develop trust with my employees.

n =	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
13	15.4	15.4	15.4	53.8	0.0
	Mean: 3.08/5	SD: 1.19	Mode: 4/5		

Assembly Supervisor Survey

Administered To: Assy Supervisor Survey **Date Administered: Aug 26, 1998**

Main Report Section

7. The observation and feedback process has helped identify and fix safety hazards in our work area.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
n = 13	7.7	7.7	7.7	76.9	0.0
	Mean: 3.54/5	SD: 0.97	Mode: 4/5		

8. I would do more observations if I received some type of recognition for doing them.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
n = 13	46.2	15.4	15.4	7.7	15.4
	Mean: 2.31/5	SD: 1.55	Mode: 1/5		

9. Most employees support TSC and appreciate being observed.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
n = 13	15.4	0.0	38.5	46.2	0.0
	Mean: 3.15/5	SD: 1.07	Mode: 4/5		

10. Employees respond well to the feedback I give them.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
n = 13	0.0	23.1	7.7	53.8	15.4
	Mean: 3.62/5	SD: 1.04	Mode: 4/5		

11. The observation sheet is very helpful and easy to use.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
n = 13	0.0	0.0	23.1	61.5	15.4
	Mean: 3.92/5	SD: 0.64	Mode: 4/5		

12. I think management is providing adequate support for TSC to be successful.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
n = 13	7.7	30.8	30.8	23.1	7.7
	Mean: 2.92/5	SD: 1.12	Mode: */5		

Assembly Supervisor Survey

Administered To: Assy Supervisor Survey | Date Administered: Aug 26, 1998

Main Report Section

#	Item	(R)	n	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Mean	SD	Mode
13.	Management still focuses on the wrong things and punishes people for injuries.	(R)	13	15.4	30.8	23.1	23.1	7.7	2.77/5	1.24	2/5
14.	Employees are starting to give each other feedback about at-risk behaviors.		13	0.0	0.0	23.1	69.2	7.7	3.85/5	0.55	4/5
15	I really don't have time to do an observation daily.	(R)	13	15.4	61.5	7.7	7.7	7.7	2.31/5	1.11	2/5
16.	I don't usually hear about what the SIG team is working on.	(R)	13	15.4	30.8	15.4	15.4	23.1	3.00/5	1.47	2/5
17.	Most employees don't know what the SIG team does.	(R)	13	15.4	15.4	15.4	30.8	23.1	3.31/5	1.44	4/5

DELIVERABLE H

IMPLEMENTATION OF THE WIXEL EXECU-TRAX WASTE MANAGEMENT SOFTWARE AT NASSCO

NATIONAL SHIPBUILDING RESEARCH PROGRAM
PANEL SP-8
PROJECT 8-96-3

APPLICATION OF INDUSTRIAL ENGINEERING TECHNIQUES TO REDUCE WORKERS' COMPENSATION AND ENVIRONMENTAL COSTS

DELIVERABLE H

IMPLEMENTATION OF THE WIXEL EXECU-TRAX WASTE MANAGEMENT SOFTWARE AT NASSCO

SUBMITTED BY:

THOMAS FAWCETT
PROJECT MANAGER

FRED HOGAN
PROJECT ENGINEER

Table of Contents

Application of Industrial Engineering Techniques to Reduce Worker Compensation and Environmental Costs N8-96-3

Implementation of the Wixel ExecuTrax Waste Management Software

1.0 Introduction

As a sub-task of the NSRP project, *Application of Industrial Engineering Techniques to reduce Workers Compensation and Environmental Costs (8-96-3),* the NASSCO Environmental Engineering Department performed an investigation of various waste management software. The investigation involved searching for efficient methods of tracking costs and volume of hazardous and non-hazardous wastes using industrial engineering techniques. The hazardous material/waste management software ExecuTrax from Wixel, Inc. was chosen for its capabilities for an optimum management of information.

This report describes the logistics of implementing the software at the NASSCO shipyard.

2.0 Industrial Engineering & Environmental Management

The promulgation of more stringent environmental laws and regulations over the past two decades has prompted the industrial community, including the shipbuilding and repair industry, to expand its efforts to comply with the laws and regulations and to proactively manage hazardous wastes. The costs to control and dispose of generated hazardous wastes has risen steadily as a result of those enacted laws and regulations.

Industrial engineering human factors techniques have been applied to various shipyard production processes for many years. However, the application of industrial engineering techniques to the shipyard environmental management for a better cost control and increased productivity has been limited. In this sub-task, a waste management software has been chosen and is in the process of being instituted to the NASSCO shipyard to demonstrate the benefits of implementing industrial engineering techniques for better environmental management practices.

3.0 Hazardous Material/Waste Tracking at NASSCO

There had been no efficient methods of characterizing and tracking the cost and volume of hazardous and non-hazardous wastes that were generated from production operations at the NASSCO shipyard. The tracking system that had been used at NASSCO was archaic, slow, and labor intensive.

It was recognized that there would be significant benefits to NASSCO should an automated process be implemented for effective tracking, segregation, and assignment of

disposal costs to the producing departments. Such a process would also allow NASSCO to identify and track waste streams that can be evaluated for the waste minimization efforts.

4.0 Hazardous Material/Waste Management Software Evaluation

The NASSCO Environmental Engineering Department evaluated over fifteen waste management software that were available on the market.

NASSCO Environmental Engineering set the following specific criteria for the waste management software. The software must:

- Allow the generator, the shipyard, to track waste activities from its generation to disposal;
- Allow easy and efficient tracking of waste containers throughout the waste generating activities;
- Has the ability to allocate waste volume and disposal costs to each generating department or area;
- Has the ability to integrate all related data into one program;
- Has the ability to track and maintain archive and current data;
- Has a capability to generate reports for the regulatory agencies;
- Be inexpensive to be recommended to the US shipyards;
- Be user friendly and easy to use for those who are less computer literate; and
- Run on a PC-based computer system preferably with network link capabilities;

Most software offered variety of capabilities that were above and beyond what NASSCO Environmental Engineering was seeking. Some offered linking the waste generating activities to other activities including material purchase, production scheduling, and accounting. The cost of some software was as much as $30,000.

*5.0 Wixel ExecuTrax Waste Management Software & the Benefits**5.0 Wixel ExecuTrax Waste Management*

The NASSCO Environmental Engineering Department chose Wixel ExecuTrax Waste Management Software to be implemented at the NASSCO shipyard.

ExecuTrax is a PC-based “user-friendly” software with various capabilities for an effective waste management. ExecuTrax allows the hazardous waste generator a precise “Cradle-to-Grave” waste management tracking. It also has a built-in warning system that provides prevention of violations and waste profile expirations, thus, allowing the generator to avoid fines and penalties. It contains pre-populated databases that integrate all related data into one program. Commonly used information such as the generator information, the transporter information, and the treatment, storage, and disposal facility information need only be entered once, and the software handles cross-referencing of pertinent information to all necessary areas of the system. This promotes data uniformity and significantly reduces the possibility of errors that can be caused by multiple users. ExecuTrax produces informative and accurate reports for management analysis tools and

for submitting to the regulatory agencies. It has the network capabilities that provide instant access to all users involved. It also has the capabilities to adapt and customize the program to the particular requirements of the user and user's systems.

ExecuTrax was the most cost efficient system among the software NASSCO Environmental Engineering evaluated. NASSCO purchased the multi-user license for ExecuTrax for $5,100. NASSCO also purchased the technical support contract for $1,100 annually. The technical support contract entails receiving technical support services and any future software upgrades.

All the capabilities ExecuTrax provide will allow the NASSCO Environmental Engineering Department an efficient collection and management of information related to hazardous and non-hazardous wastes. Furthermore, the data collected will enable the Environmental Engineering Department to identify areas within the NASSCO shipyard that generate large quantities of wastes and to apply industrial engineering techniques to those areas for process improvements for waste reduction and disposal cost reduction.

In summary the major benefits are:

1. Reduction in the biennial hazardous waste report preparation time.
    a. 80 hours to 8 hours (approx.)
2. Ease of hazardous waste generator fee and tax calculation.
3. Increase efficiency of the waste management information tracking.
4. Ability to integrate into an environmental management system.

6.0 Implementation of Wixel ExecuTrax at NASSCO

6.1 ExecuTrax Software User Training

The NASSCO Environmental Engineering Department staff and the NASSCO HAZMAT personnel received a three-day training on how to use ExecuTrax.

6.2 Data Input

The software has been purchased and installed in the NASSCO computer system network. As with any data management software, ExecuTrax requires initial loading of information pertaining to the NASSCO operations. The following information has been entered into the waste module of ExecuTrax to customize to the NASSCO operations:

6.3 Generator Information

The information pertinent to waste management practices at NASSCO has been entered. The EPA identification number, the state identification number, NASSCO address, point of contact, and telephone numbers have been entered.

6.4 Waste Generating Departments

To aid in the waste minimization efforts, the contents of each wastes container are assigned to their generating department/area. A total of 32 generating

departments of NASSCO have been identified and entered into the ExecuTrax system. See Attachment A. NASSCO Department List.

6.5 On-Site Waste Streams

A total of 44 different hazardous waste streams are generated from the NASSCO operations. They range from oily waste water to flammable aerosol cans. Those 44 waste streams have been loaded to the ExecuTrax waste module. A list of NASSCO On-Site Waste Stream in included in this report as Attachment B. The Attachment C, Waste Stream List describes the waste streams by the proper DOT shipping name and EPA waste codes. The information as shown in the Attachments B and C will allow the Environmental Engineering Department to generate accurate waste reports to be submitted to regulatory agencies such as EPA and Cal EPA.

6.6 Transporter Information

NASSCO currently uses four transporters for shipping hazardous wastes to various treatment, storage and disposal facilities (TSDF's). The Attachment D lists the transporters.

6.7 TSDF Information

NASSCO currently uses TSDF's for disposal of its hazardous wastes. The Attachment E lists the active TSDF's.

6.8 Active Profiles

There are 44 active NASSCO hazardous waste profiles that have been set up with various TSDF's for proper hazardous waste disposal. The Attachment F lists the active profiles.

6.9 Hazardous Waste Disposal Costs

One of ExecuTrax's capabilities is allowing the generator to track hazardous waste disposal costs. The disposal cost for each waste stream has been entered into ExecuTrax as shown in the Attachment G.

6.10 On-Site Container List

The Attachment H, On-Site Container List, illustrates some of the waste containers that were on site at the NASSCO shipyard that were ready for transport to an off-site TSDF. The accurate container tracking is essential to processing the wastes on time to avoid any enforcement actions by the regulatory agencies.

6.11 Producing a Waste Shipment

ExecuTrax allows the generator three different ways to produce shipments. The waste can be produced by the containers, by waste streams, or by shipping names. Each has its own advantages. Producing the shipment by the containers allows the

generator a greater control over keeping track of container inventory. Producing the shipment by the shipping name is recommended only for printing waste manifests.

6.12 Generating Hazardous Waste Manifest

ExecuTrax compiles the information that has been entered and generates a hazardous waste manifest. The generator information, transporter information, TSDF information, waste information with the proper US DOT shipping description, any special handling information will be printed on the manifest. The Attachment I is a copy of the ExecuTrax generated Uniform Hazardous Waste Manifest with the pertinent information that would be on a real manifest. This manifest was generated from the NASSCO waste information that was entered into the software.

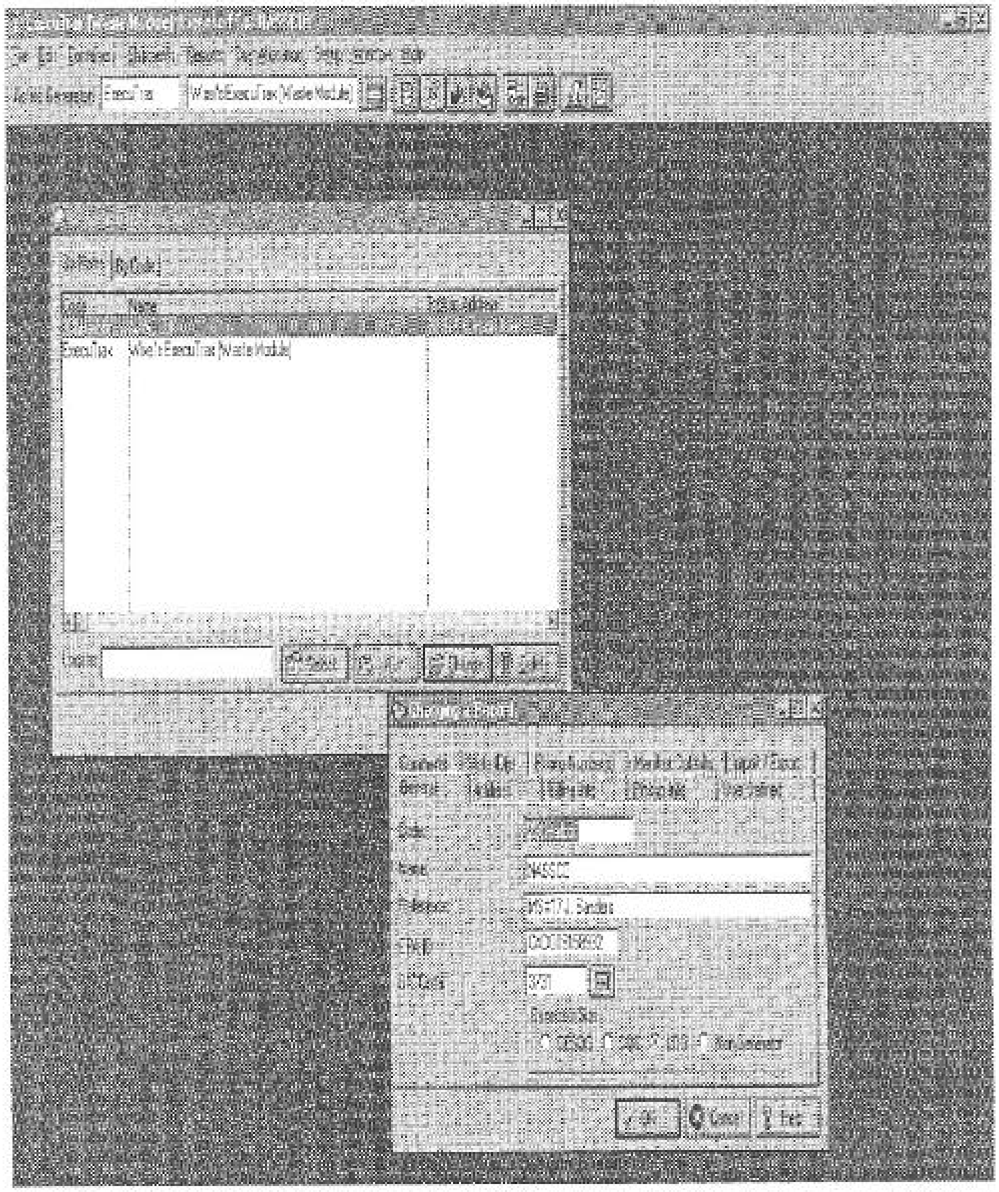
7.0 Conclusion and Recommendation

With the simplicity and ease of use of Wixel ExecuTrax, NASSCO foresees a great opportunity in streamlining its waste information management. The data collected will enable the Environmental Engineering Department to identify areas within the NASSCO shipyard that generate large quantities of wastes for waste reduction efforts. Furthermore, NASSCO will be able to apply various industrial engineering techniques to those areas for process improvements and cost reduction.

The findings from this sub-task of the NSRP project N8-96-3 indicate that there is a great potential for applying industrial engineering techniques for better and efficient environmental management. Using a tool such as the ExecuTrax waste management software will be beneficial to the US shipyard industry for the better environmental management, process improvements, and cost reduction.

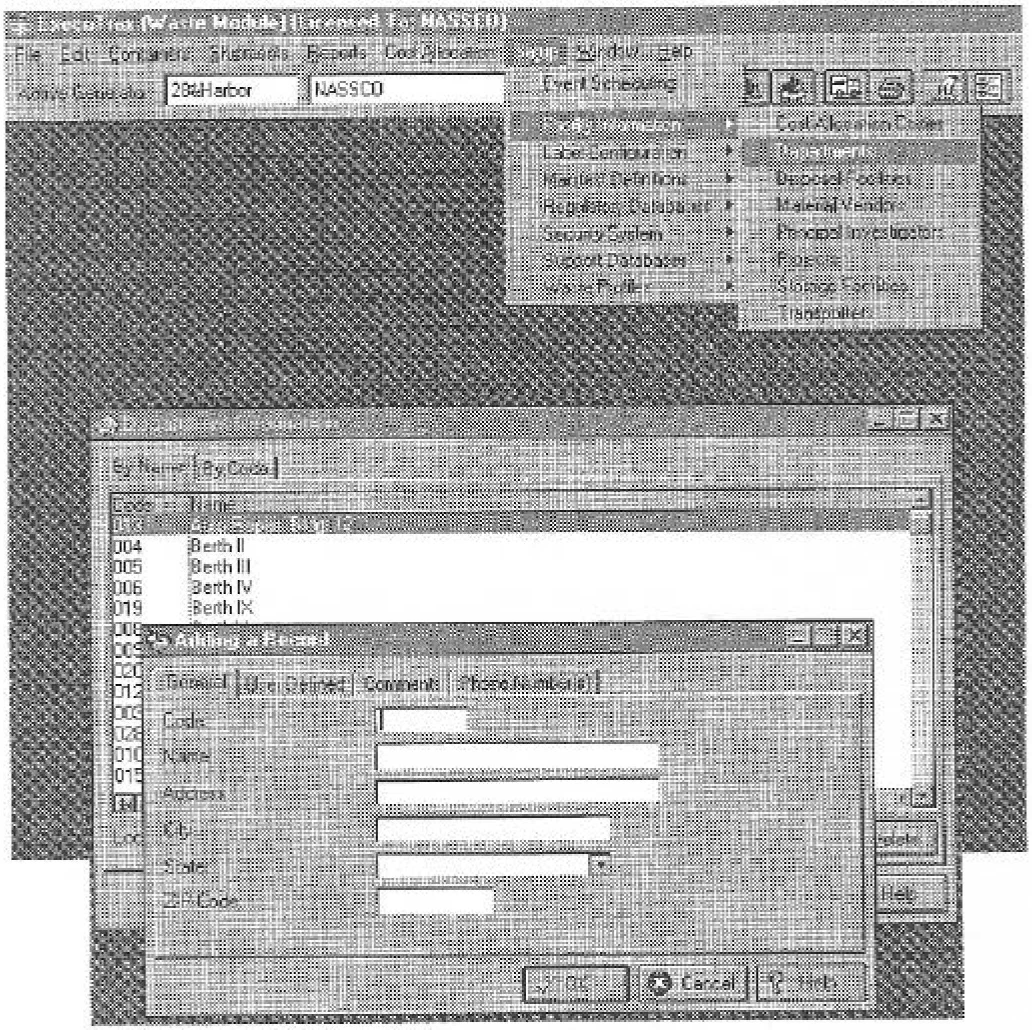
Attachments

1. Creating & Selecting a Generator Database



Generator List Box and Document Window

2. Entering Department Information



Department Information List Box & Document Window

NASSCO

Department List   Printed: 6/25/98

Name: Flame Spray   Code: 015
Address: 28th & Harbor Dr.
San Diego   CA 92113

Description	Phone	Extension	Contact
Flame Spray	(619) 544-8549		Roberta Schwab

Name: Floating Drydock   Code: 026
Address: 28th & Harbor Dr.
San Diego   CA 92113

Description	Phone	Extension	Contact
Floating Drydock	(619) 544-8775		Akbar Gaya
Floating Drydock	(619) 544-3450		Joe Pritchard
Floating Drydock	(619) 544-3601		Lee Downing

Name: GNP Area   Code: 007
Address: 28th & Harbor Dr.
San Diego   CA 92113

Description	Phone	Extension	Contact
GNP Area	(619) 544-8549		Roberta Schwab

Name: Grit Blast Area, Bldg. 70   Code: 017
Address: 28th & Harbor Dr.
San Diego   CA 92113

Description	Phone	Extension	Contact
Grit Blast Area	(619) 544-7578		Art Allen

Name: Hopeman Brothers   Code: 022
Address: 28th & Harbor Dr.
San Diego   CA 92113

Description	Phone	Extension	Contact
Hopeman Bros.	(619) 544-7729		Pat Murray

Name: Machine Shop, Bldg. 8   Code: 027
Address: 28th & Harbor Dr.
San Diego   CA 92113

Description	Phone	Extension	Contact
Machine Shop	(619) 544-8421		John Walden

ExecuTrax (Waste Module)   Page: 3

NASSCO
CAD009158932

EPA Hazardous Waste Report - Form GM Worksheet
Between 1/01/98 and 12/31/98

Printed: 9/15/98

Section I:

A. Waste Description: Ansul Fire Protection

Waste Profile: AFFF
Code: 0001
EPA Hazard Class: None
Additional Desc:

– DOT Shipping Description –
Non-RCRA Hazardous Waste Liquid, Fire Protection Compound

Hazardous Material   X Regulated

B. EPA Hazardous Waste Code(s):
(None Specified)

C. State Waste Code(s): 343

D. SIC Code: 3731 E. Origin Code: F. Source Code: G. Point of Measurement:

H. Form Code: I. RCRA Radioactive: 2

Section II:

A. Quantity Produced in Previous Period: 0.00 (1/01/1997 - 12/31/1997)
B. Quantity Generated in Current Period: 0.00
C. UOM: 1 Density: 1.000 (Specific Gravity)

Section III:

*** Waste was not shipped off-site ***

ExecuTrax Waste Module   Page: 1

NASSCO

CAD009158932

EPA Hazardous Waste Report - Form GM Worksheet
Between 1/01/98 and 12/31/98

Printed: 9/18/98

Section I:

A. Waste Description: Contaminated Soil from Storm Darin Clean Out

Waste Profile: Contaminated Soil **Code:** 0002
EPA Hazard Class: Listed
Additional Desc:

DOT Shipping Description
"RQ", Hazardous Waste, Solid, N.O.S., NA3077, RQ1, PGIII

☐ Hazardous Material ☒ Regulated

B. EPA Hazardous Waste Code(s):
D005,D007,D008

C. State Waste Code(s): 171

D. SIC Code: 3731 **E. Origin Code:** 1 **F. Source Code:** A19 **G. Point of Measurement:**

H. Form Code: B302 **I. RCRA Radioactive:** 2

Section II:

A. Quantity Produced in Previous Period: 0.00 (1/01/1997 - 12/31/1997)
B. Quantity Generated in Current Period: 1,200.00
C. UOM: 1 **Density:** 1.000 (Specific Gravity)

Section III:

Site 1

B. EPA ID Number of Facility: CAD050806850 (Laidlaw Environmental Services)
C. System Type(s) Shipped To: M141

D. Off-site Availability Code: 1
E. Total Quantity Shipped: 1,200.00 (Quantity as it appeared on the manifests)

ExecuTrax (Waste Module) Page: 2

NASSCO

On-Site Container List

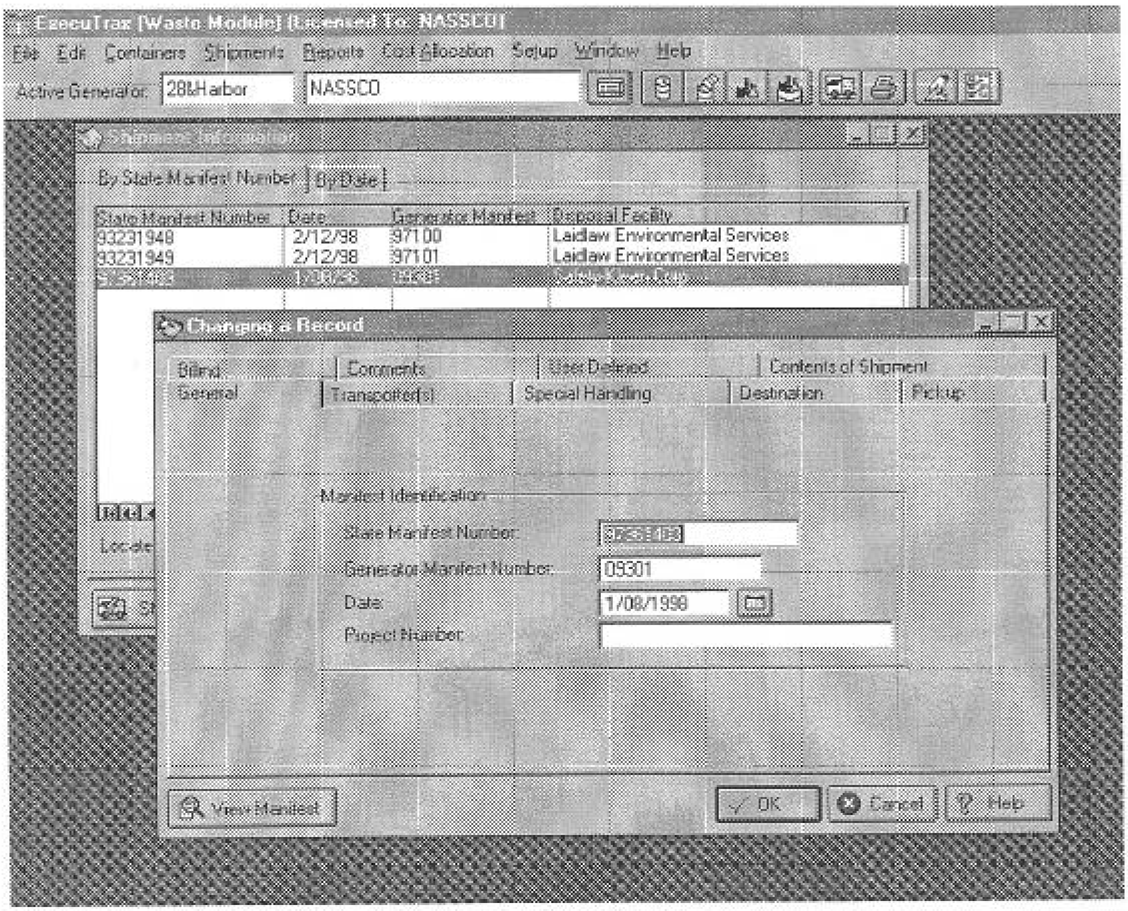
Printed: 8/26/98

Container/Alt Container	Date	Location	Row	Col	Layer	# Days
DM-98-00001	8/24/98 Waste Stream: Petroleum Naphtha					2
DM-98-00002	8/24/98 Waste Stream: Petroleum Naphtha					2
DM-98-00003	8/24/98 Waste Stream: Petroleum Naphtha					2
DM-98-00004	8/24/98 Waste Stream: Petroleum Naphtha					2
DM-98-00005	8/24/98 Waste Stream: Petroleum Naphtha					2
DM-98-00006	8/24/98 Waste Stream: Petroleum Naphtha					2
DM-98-00007	8/24/98 Waste Stream: Petroleum Naphtha					2
DM-98-00008	8/24/98 Waste Stream: Petroleum Naphtha					2

ExecuTrax (Waste Module)

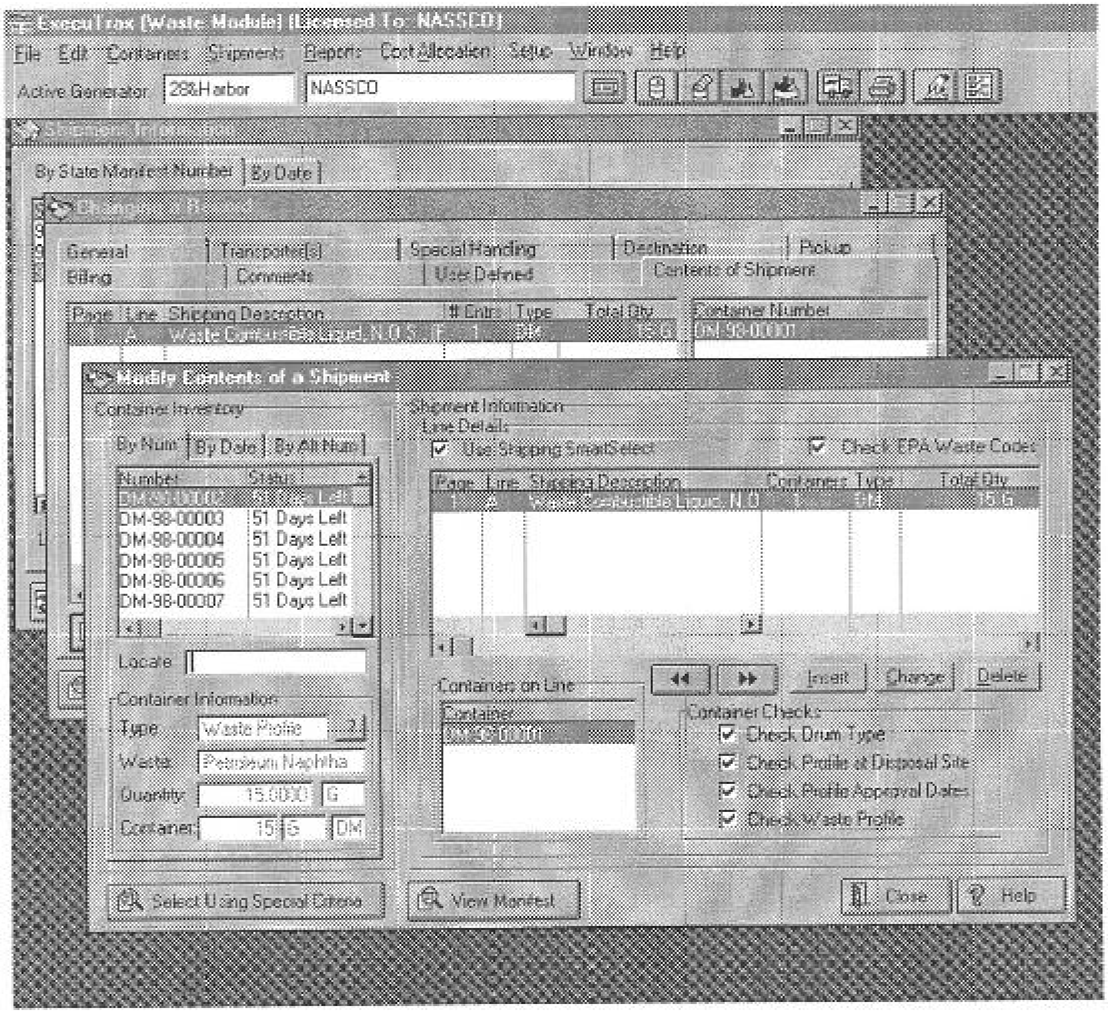
Page: 1

8. Entering Shipment Information



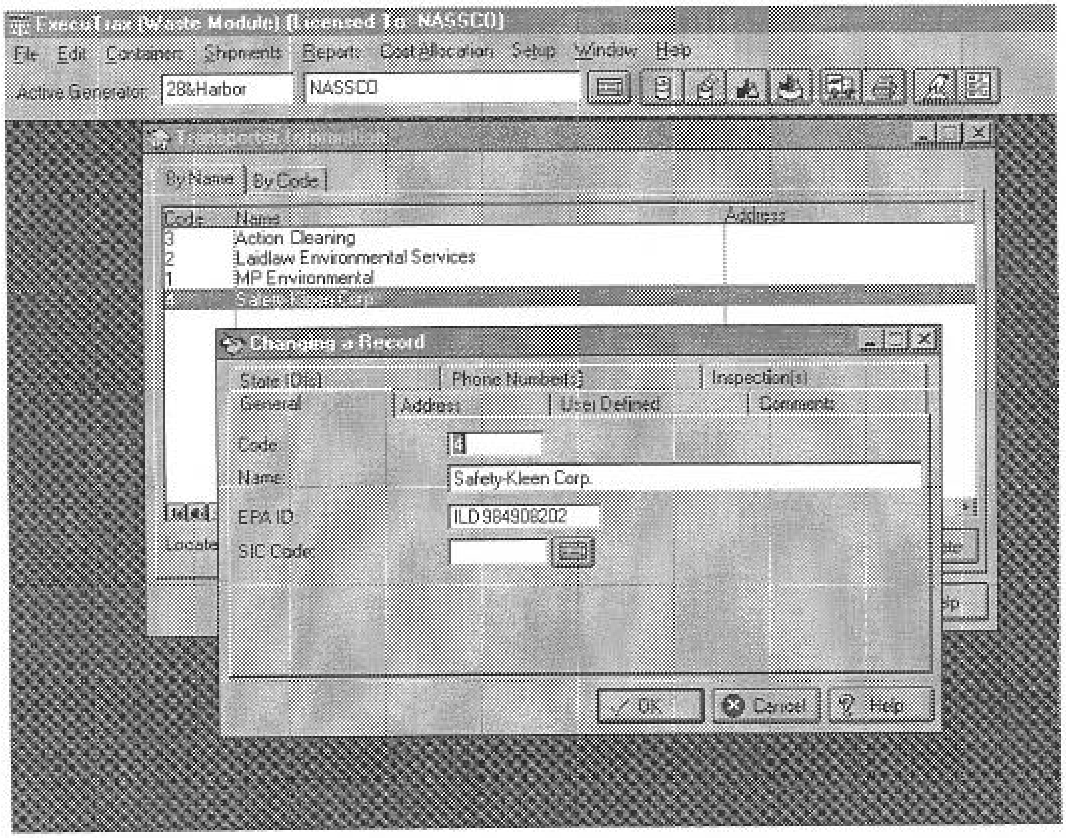
Shipment Information List Box and Document Window

8.1 Entering Shipment Information by Container



Modify Contents of a Shipment Document Window

4. Entering Transporter Information



Transporter Information List Box & Document Window

NASSCO

Transporter List — Printed: 8/19/98

Name: Action Cleaning — Code: 3
Address:

County:

EPA ID: CAD980812978 — SIC Code:

Description	Phone	Extension	Contact
Action Cleaning	(619) 233-1881		

Name: Laidlaw Environmental Services — Code: 2
Address:

County:

EPA ID: CAD000083121 — SIC Code:

Description	Phone	Extension	Contact
	(619) 344-9400		

Name: MP Environmental — Code: 1
Address:

County:

EPA ID: CAT000624247 — SIC Code:

Description	Phone	Extension	Contact
	(800) 393-1151		

Name: Safety-Kleen Corp. — Code: 4
Address:

County:

EPA ID: ILD984908202 — SIC Code:

Description	Phone	Extension	Contact
Safety-Kleen	(800) 669-5740		

ExecuTrax (Waste Module) — Page: 1

Please print or type. (Form designed for use on elite (12-pitch) typewriter.)

Form NOT Approved. NO OMB Number.

UNIFORM HAZARDOUS WASTE MANIFEST	1. Generator's US EPA ID No. CAD009158932	Manifest Document No. 09301	2. Page 1 of 1	Information in the shaded areas is not required by Federal law.

3. Generator's Name and Mailing Address NASSCO
28th & Harbor Drive
San Diego, CA 92113

4. Generator's Phone (619) 544-7736

A. State Manifest Document Number 97361403

B. State Generator's ID HA-HQ-36-005218

5. Transporter 1 Company Name Safety-Kleen Corp.

6. US EPA ID Number ILD984908202

C. State Transporter's ID

D. Transporters Phone (800)669-5740

7. Transporter 2 Company Name

8. US EPA ID Number

E. State Transporter's ID

F. Transporter's Phone

9. Designated Facility Name and Site Address
Safety-Kleen Corp.
2120 S. Yale St.
Santa Ana, CA 92704

10. US EPA ID Number CAT000613976

G. State Facility's ID

H. Facility's Phone (714)241-7047

11. US DOT Description (Including Proper Shipping Name, Hazard Class, and ID Number)	HM	12. Containers No.	Type	13. Total Quantity	14. Unit Wt/Vol	I. Waste No.
a. Waste Combustible Liquid, N.O.S., (Petroleum Naphtha), NA1993		1	DM	15	G	D039, D008 D018, D040
b.						
c.						
d.						

GENERATOR

J. Additional Description for Materials Listed Above

K. Handling Codes for Wastes Listed Above

15. Special Handling Instructions and Additional Information

16. **GENERATORS CERTIFICATION:** I hereby declare that the contents of this consignment are fully and accurately described above by proper shipping name and are classified, packed, marked, and labeled, and are in all respects in proper condition for transport by highway according to applicable international and national government regulations.
If I am a large quantity generator, I certify that I have a program in place to reduce the volume and toxicity of waste generated to the degree I have determined to be economically practicable and that I have selected the practicable method of treatment, storage, or disposal currently available to me which minimizes the present and future threat to human health and the environment; OR, if I am a small quantity generator, I have made a good faith effort to minimize my waste generation and select the best waste management method that is available to me and I can afford.

Printed / Typed Name | Signature | Month Day Year

TRANSPORTER

17. Transporter 1 Acknowledgement of Receipt of Materials

Printed / Typed Name | Signature | Month Day Year

18. Transporter 2 Acknowledgement of Receipt of Materials

Printed / Typed Name | Signature | Month Day Year

FACILITY

19. Discrepancy Indication Space

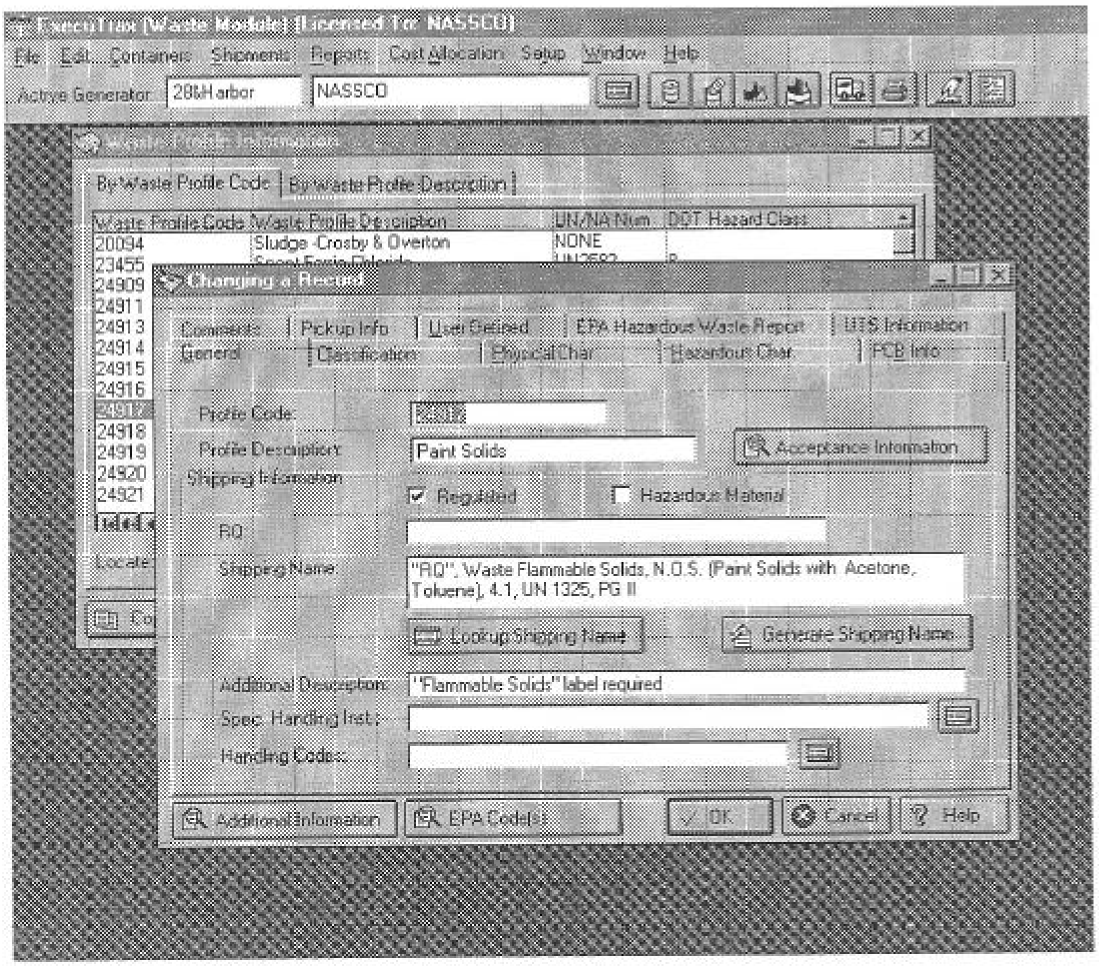
20. Facility Owner or Operator: Certification of receipt of hazardous materials covered by this manifest except as noted in Item 19.

Printed / Typed Name | Signature | Month Day Year

THIS IS NOT A LEGAL DOCUMENT

EPA Form 8700-22 (Rev. 9-88) Previous editions are obsolete.

5. Entering Waste Profile Definition Information



Waste Profile Information List Box & Document Window

NASSCO

Waste Stream List — Printed: 8/03/98

General Information

Description: Batteries — Code: 309104

RQ: ☐ Regulated ☐ Hazardous Material

DOT Shipping Description:

Non-RCRA Waste Alkaline Batteries

UN/NA Number:	NONE	Packing Group:	
Hazard Class:		Origin Code:	1
EPA Hazard Class:	None	Form Code:	B009
		Gen Source Code:	A99

Additional Description:

Special Handling Instructions:

ExecuTrax (Waste Module) — Page: 5

NASSCO

Waste Stream List

Printed: 8/03/98

General Information

Description: Paint Solids

Code: 24917

RQ: ☒ Regulated ☐ Hazardous Material

DOT Shipping Description:

"RQ", Waste Flammable Solids, N.O.S. (Paint Solids with Acetone, Toluene), 4.1, UN 1325, PG II

UN/NA Number:	1325	Packing Group: II		Origin Code:	1
Hazard Class:	4.1			Form Code:	B604
EPA Hazard Class:	Ignitable			Gen Source Code:	A21

Additional Description: "Flammable Solids" label required

Special Handling Instructions:

EPA Waste Code(s)

Code	Weight	LB Sub-Category
D001	0.0	
D035	0.0	

NASSCO

Waste Stream List | Printed: 8/03/98

General Information

Description: Petroleum Naphtha | **Code:** Safety-Kln

RQ: ☒ **Regulated** ☐ **Hazardous Material**

DOT Shipping Description:

Waste Combustible Liquid, N.O.S., (Petroleum Naphtha), NA1993

UN/NA Number:	1993	**Packing Group:**		**Origin Code:**	1
Hazard Class:				**Form Code:**	B202
EPA Hazard Class:	Listed			**Gen Source Code:**	A19

Additional Description:

Special Handling Instructions:

EPA Waste Code(s)

Code	Weight	LB Sub-Category
D039	0.0	

General Information

Description: Zinc Primer

Code: 25544

RQ: ☐ Regulated ☐ Hazardous Material

DOT Shipping Description:

Non-RCRA, Hazardous Waste Solid, (Zinc Primer)

UN/NA Number: NONE

Hazard Class:

EPA Hazard Class: None

Packing Group:

Origin Code: 1

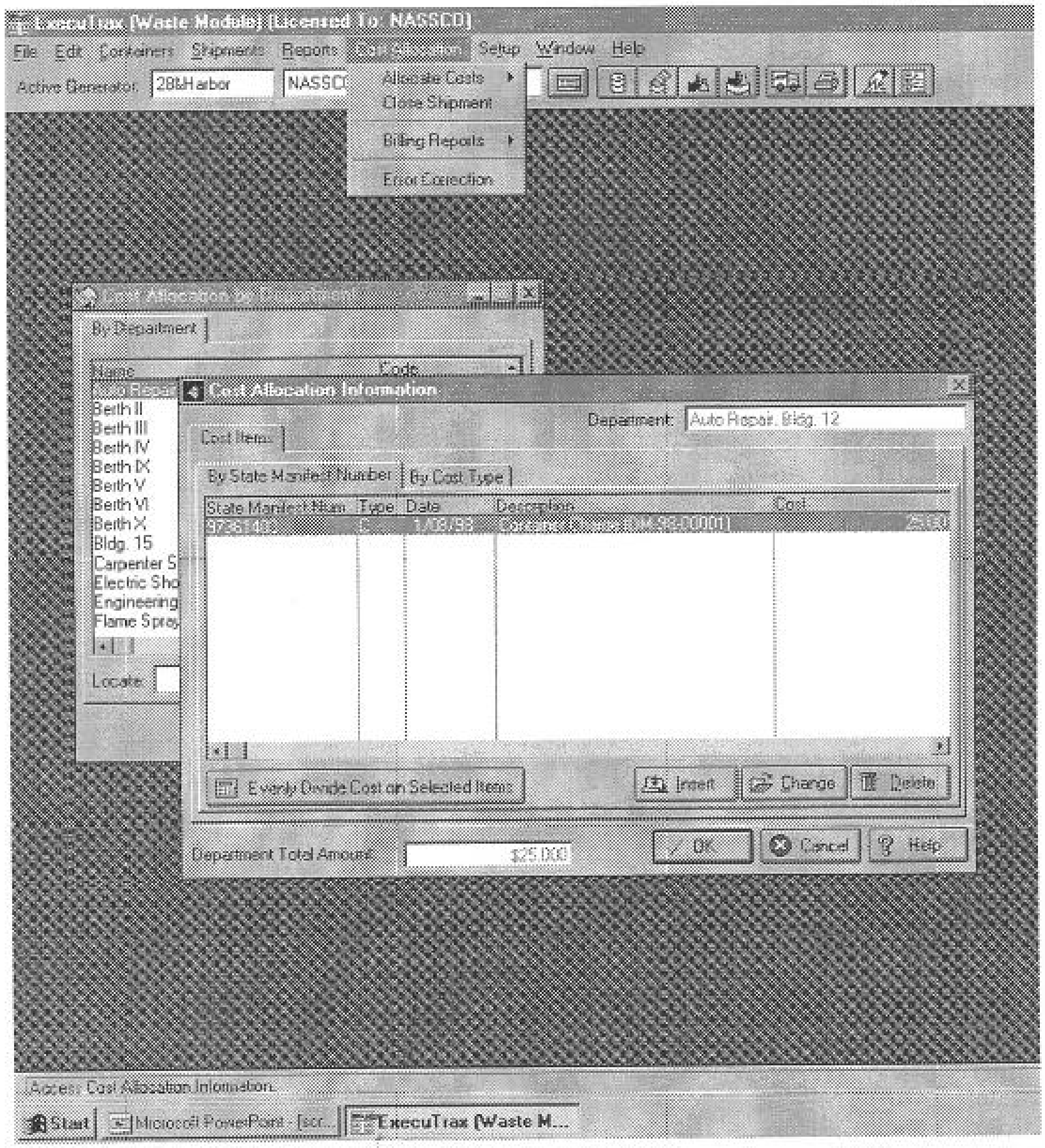
Form Code: B409

Gen Source Code: A99

Additional Description:

Special Handling Instructions:

11. Cost Allocation



Cost Allocation Information By Dept. Document Window

NASSCO

TSD Pricing

Printed: 8/19/98

Waste Stream: Oil Filter Cake

Cost Code	Description	Cost	Cost Type
30GD	30-gal drum	242.000	
55GD	55-gal drum	285.000	
XPORT	Transportation cost	450.000	

Waste Stream: Oily Waste Water

Cost Code	Description	Cost	Cost Type

Waste Stream: Paint Booth Filters

Cost Code	Description	Cost	Cost Type
30GD	30-gal drum	166.000	
55GD	55-gal drum	195.000	
XPORT	Transportation cost	450.000	

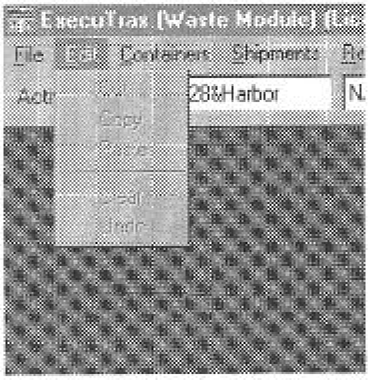
Waste Stream: Paint Solids

Cost Code	Description	Cost	Cost Type
30GD	30-gal drum	238.000	
55GD	55-gal drum	280.000	
XPORT	Transportation cost	450.000	

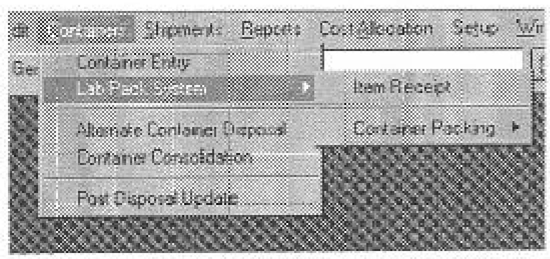
Waste Stream: Photographic & Blueprint

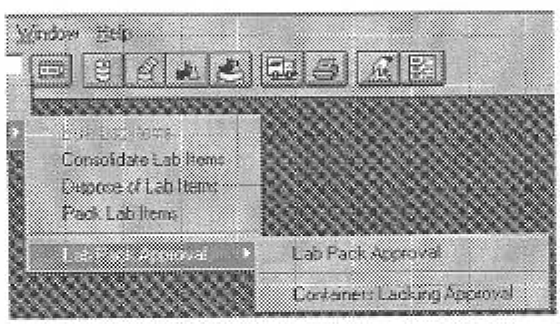
Cost Code	Description	Cost	Cost Type
30GD	30-gal drum	160.000	
55GD	55-gal drum	188.000	
XPORT	Transportation cost	450.000	

"Edit" Screens:



"Containers" Screens





Please print or type. (Form designed for use on elite (12-pitch) typewriter.)

Form NOT Approved. NO OMB Number.

UNIFORM HAZARDOUS WASTE MANIFEST	1. Generator's US EPA ID No. CAD009158932	Manifest Document No. 97100	2. Page 1 of 1

Information in the shaded areas is not required by Federal law.

3. Generator's Name and Mailing Address NASSCO
28th & Harbor Drive
San Diego, CA 92113
4. Generator's Phone (619) 544-7736

A. State Manifest Document Number 93231948
B. State Generator's ID HA-HQ-36-005218

5. Transporter 1 Company Name Laidlaw Environmental Services
6. US EPA ID Number CAD000083121
C. State Transporter's ID
D. Transporters Phone (619)344-9400

7. Transporter 2 Company Name
8. US EPA ID Number
E. State Transporter's ID
F. Transporter's Phone

9. Designated Facility Name and Site Address
Laidlaw Environmental Services
5756 Alba Street
Los Angeles, CA 90058
10. US EPA ID Number CAD050806850
G. State Facility's ID
H. Facility's Phone (213)585-5063

GENERATOR

	HM	11. US DOT Description (Including Proper Shipping Name, Hazard Class, and ID Number)	12. Containers No.	Type	13. Total Quantity	14. Unit Wt/Vol	I. Waste No.
a.		Waste Flammable Solids, Organic, N.O.S. (Rags Contaminated with Paint, Petroleum Distillates), 4.1, UN1325, PG II	28	DM	4,200	P	D001
b.		Aerosols, flammable, (EACH NOT EXCEEDING 1 L CAPACITY), UN1950	11	DM	1,375	P	D001
c.		Non-RCRA Hazardous Waste, Solid (Oil Contaminated Absorbent)	5	DM	750	P	none
d.		Non-RCRA, Hazardous Waste Solid, Wax/Grease	6	DM	2,400	P	none

J. Additional Description for Materials Listed Above
LINE A: SDNAS-24926: Contaminated Rags "Flammable Solid" label required
LINE B: SDNAS-24911:Spray Cans
LINE C: SDNAS-24915: Oil Absorbent
LINE D: SDNAS-24927: Wax/Grease

K. Handling Codes for Wastes Listed Above

15. Special Handling Instructions and Additional Information

16. **GENERATORS CERTIFICATION:** I hereby declare that the contents of this consignment are fully and accurately described above by proper shipping name and are classified, packed, marked, and labeled, and are in all respects in proper condition for transport by highway according to applicable international and national government regulations.
If I am a large quantity generator, I certify that I have a program in place to reduce the volume and toxicity of waste generated to the degree I have determined to be economically practicable and that I have selected the practicable method of treatment, storage, or disposal currently available to me which minimizes the present and future threat to human health and the environment; OR, if I am a small quantity generator, I have made a good faith effort to minimize my waste generation and select the best waste management method that is available to me and I can afford.

Printed / Typed Name	Signature	Month Day Year

TRANSPORTER

17. Transporter 1 Acknowledgement of Receipt of Materials

Printed / Typed Name	Signature	Month Day Year

18. Transporter 2 Acknowledgement of Receipt of Materials

Printed / Typed Name	Signature	Month Day Year

FACILITY

19. Discrepancy Indication Space

20. Facility Owner or Operator: Certification of receipt of hazardous materials covered by this manifest except as noted in item 19.

Printed / Typed Name	Signature	Month Day Year

THIS IS NOT A LEGAL DOCUMENT

EPA Form 8700-22 (Rev. 9-88) Previous editions are obsolete.

DELIVERABLE I

COMPUTER BASED TRAINING MODULE DEVELOPMENT

Application of Industrial Engineering Techniques to Reduce Worker Compensation and Environmental Costs N8-96-3

Development of Computer Based Training (CBT) Module

1.0 Introduction

As a sub-task of the NSRP project, *Application of Industrial Engineering Techniques to Reduce Workers Compensation and Environmental Costs (8-96-3)*, the NASSCO Training Department and Environmental Engineering Department developed an interactive, computer based training (CBT) module. The objective of this sub-task was to provide computer-based training to shipyard personnel on environmental issues that impact the shipyard operation and production. The CBT module that was developed addresses the training requirements for the NASSCO shipyard personnel who are engaged in transfers of oil and bulk quantity hazardous materials over water. The contents of the CBT module are in accordance with the US Coast Guard regulations as specified in 33 Code of Federal Regulations (CFR) 154 and 156.

This report describes the logistics of how the CBT module was developed for the NASSCO shipyard.

2.0 Industrial Engineering & Environmental Management

The promulgation of more stringent environmental laws and regulations over the past two decades has prompted the shipbuilding and repair industry to train its employees on many environmental regulatory issues. As a result, the costs and resource allocation needs to train the shipyard employees on those environmental regulatory issues have increased significantly.

Industrial engineering human factor techniques have been applied to various shipyard production processes for many years. However, the application of industrial engineering techniques to the shipyard environmental management for a better cost control and increased productivity has been limited. In this sub-task, an interactive, computer-based training module was developed for training NASSCO shipyard employees to demonstrate the benefits of implementing industrial engineering techniques for better environmental management and cost control practices.

3.0 Current Environmental Training Approach at NASSCO

The NASSCO Training Department and Environmental Engineering Department offer a number of environmental training courses to employees as required by various regulatory agencies. All courses have an instructor-led, in-classroom-training format that relies on the efficiency of instructors. One of the disadvantages to this type of training format is that the students attend the training in accordance with the instructor's schedule that may be in conflict with the students' schedule. This is especially true for those students who require to be re-trained to stay compliant with the federal or local regulations. The impact on the production schedule and man-hour can be staggering: it has been estimated that the cost to provide this type of training can range from $100 to $200 per hour.

4.0 The Person-In-Charge Training

The NASSCO employees who are engaged in the over-water transfer of oil and bulk-quantity hazardous materials are required to be trained per the US Coast Guard requirements as specified in the 33 CFR 154-156. These employees are designated as Persons-In-Charge and must be trained on an annual basis. The NASSCO Environmental Engineering Department chose the PIC training as the topic for which the CBT be developed. Approximately 30 NASSCO PIC's receive training annually on the PIC requirements.

The PIC training module that was developed under the NSRP project number 8-96-3 was used for developing the CBT module text. The text was written to be specific to NASSCO operations. Because of NASSCO's multi-cultural workforce whose first language may be other than English, a special attention was paid to the text write up.

5.0 Developing the CBT Module

5.1 Computer Hardware Requirements

An IBM compatible personal computer with a Pentium-233 processor and the Windows NT operating system was used for authoring the CBT module. The computer has a 64-MB of RAM, a 6-GB hard drive, and a Diamond Monster Video Card with 8 MB. In addition, a Smart & Friendly 426 External CD Re-Write was used.

5.2 Computer Software

Two authoring software programs were used for developing the CBT module.

5.2.1 Macromedia Authorware Studio Suite

The Macromedia Authorware Studio Suite software package was chosen as the main authoring tool. The suite includes Authorware, Director, Xres, Backstage, Sound Editing software. Authorware is the number one selling instructional authoring software. It has an automatic conversion feature for the World-Wide-Web. Macromedia offers many outside training courses. Also, help groups are available for novice instructional designers.

5.*2.2 Designer's Edge*

Designer's Edge is a course writing tool from Allen Communication. It allows the course author or trainer step-by-step thorough course writing procedures to design an instructional program. Using Designer's Edge may allow up to 30% reduction in the CBT course authoring time.

6.0 NASSCO Environmental PIC Training: The Final Deliverable

The final deliverable of this sub-task is a CD-ROM containing the PIC CBT module titled *NASSCO Environmental PIC Training*. The CBT module is comprised of 12 sections including the student exam. The CBT module contains audio, video, text, and graphic files. It may take a student approximately two hours to thoroughly go over the module; however, the length of completion time depends greatly on each student's level of subject matter knowledge, English proficiency, computer proficiency, etc.

This CBT module was reviewed by the California State Lands Commission to ensure the accuracy of the contents.

7.0 Potential Benefits

There are many potential benefits to be realized from using the PIC CBT module: Students can schedule the training at their own convenience without impacting the NASSCO production schedule or manpower. Students can work at their own pace to gain a thorough knowledge of the subject matter. Because the students do not depend on the instructor's training efficiency, the training being provided is consistent. The CBT module is cost effective because it requires no instructor.

The initial investment to purchase the software programs is required for developing CBT modules. However, the rate of return on the investment is expected to be high. NASSCO expects to start utilizing the developed PIC CBT module in the coming weeks. NASSCO also expects to develop and use other environmental CBT modules to meet its environmental training requirements.

DELIVERABLE J

WORKSHOP PRESENTATION

WORKSHOP SUMMARY

To communicate the findings of the project “Application of Industrial Engineering Techniques to Reduce Workers’ Compensation and Environmental Cost,” three workshops were held. The first workshop was held at the Radisson Admiral Semmes Hotel in Mobile, AL October 8 & 9, 1998. The second was held at the Radisson Hotel in Portland, ME, October 15 & 16, 1998. The third was held at National Steel & Shipbuilding Company in San Diego, CA, October 22 & 23, 1998.

The workshops were scheduled in central locations throughout the country, to facilitate attendance by all of the major shipyards and repair facilities. These workshops were advertised through NSnet and an e-mail discussion group of more than 500 members. The advertising for these workshops was coordinated through the University of Michigan by Pamela Cohen. There were an additional 367 flyers mailed to members of the NSRP panels (3, 8, 9, 5 and 7) by the Project Engineer. The advertising and mailings occurred during the months of August and September to notify participants in a timely manner. A copy of the workshop announcement flyer is included in this report.

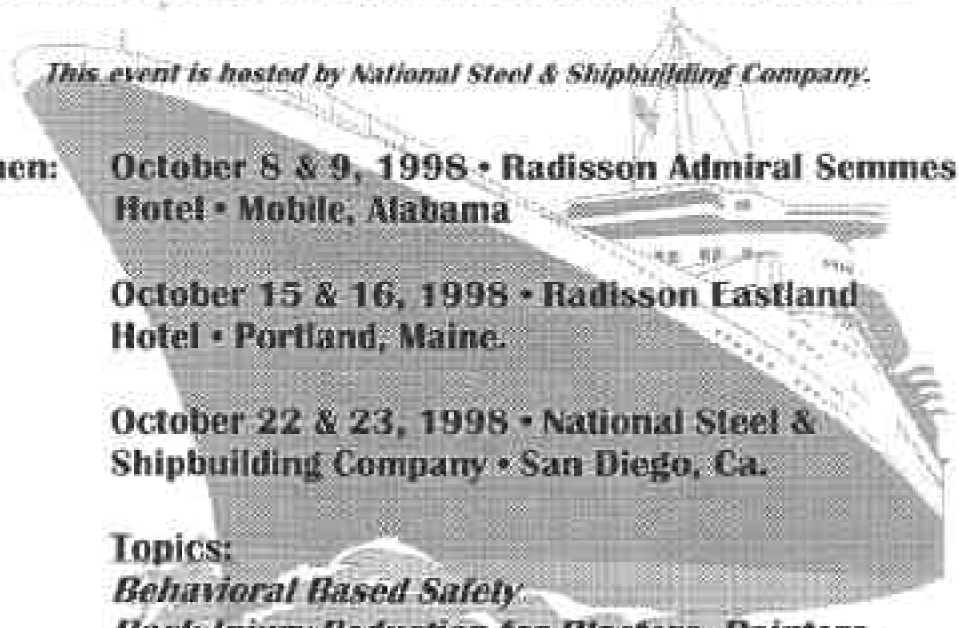
The workshop was conducted by Freddie Hogan, Project Engineer, Brienn Woodds, Manager of Training and Development, Karen Wasson, Training and Development Department and Michelle Lee, Environmental Department. The workshop agenda and workshop material are included in this report.

The workshops were well received by the attendees and provided a valuable opportunity to share the lessons learned on this project.

WorkShop

on

"Application of Industrial Engineering Techniques to Reduce Workers' Compensation And Environmental Costs"



This event is hosted by National Steel & Shipbuilding Company.

When: **October 8 & 9, 1998 • Radisson Admiral Semmes Hotel • Mobile, Alabama**

October 15 & 16, 1998 • Radisson Eastland Hotel • Portland, Maine.

October 22 & 23, 1998 • National Steel & Shipbuilding Company • San Diego, Ca.

Topics:

Behavioral Based Safety
Back Injury Reduction for Blasters, Painters, Electricians, and Steel Trades.
Environmental Tracking Software
Environmentally Compliant Spray Equipment
...... and more.

To reserve your space in any of the workshops or for more information please contact Fred Hogan at 619/544-8501 or Brienn Woods at 619/544-7967.
Note: For attendess at the San Diego workshop, please call to arrange entry into the shipyard.

Application of Industrial Engineering Techniques to Reduce Workers' Compensation and Environmental Costs

Freddie Hogan

National Steel & Shipbuilding Co.

Industrial Engineering

***Definition*:**

Integration of human, information, material, monetary and technological resources to produce goods and services; ensuring workers have the correct tools and training to get the job done efficiently, safely and with high quality.

Techniques

- Process Planning
- Ergonomics
- Process Control
- Training
- Industrial Safety
- Operations Research

Project Overview
Approach

- The project was divided into components
  - Workers’ Compensation costs
  - Environmental issues

Workers' Compensation Approach

- A safety process improvement team was chartered to address all aspects of workers' compensation costs
- Safety PIT identified high frequency or high risk of severity work areas.
  - Three areas were identified for further evaluation to reduce injuries and costs.
  - A sub-PIT of salaried and hourly workers was formed to review and analyze the causes of injury for each area

Project Overview

- Central process improvement team established with department heads from:
  - Safety Department
  - Paint & Blast
  - Human Resources
  - Training
  - Steel Erection
  - Electrical
  - Finance

Workers' Comp Cost Background

- $17 million spent in 1996
- Paint & Blast department spent $1.4M in 1996 on hand, wrist, shoulder injuries
  - Repetitive motion injury rate at 15%
  - On-Block injury rate at 11%
  - Dept. injury rate at 38%
- Electrical department spent $130,000 from 1996 to 1998 on back injuries
  - Injury rate for cable crew at 127%
- Steel erection area averaged $1.4M yearly on back injuries
  - Injury rate for steel erection at 42%

Workers' Compensation Sub PITs

- Paint & Blast
- Electrical
- Steel Erection

Paint & Blast Sub PIT

- Initial Team
  - Department Mgr.
  - Facilitator
  - Industrial Hygienist
  - Safety Dept. Mgr.
  - Quality Assurance
  - Production Supervisors
  - Hourly Employees
  - General Supervisor
  - Engineer
- Research Team
  - Facilitator
  - Engineer
  - General Supervisor
  - Production Supervisors
  - Industrial Hygienist
  - Quality Assurance

Paint & Blast Dept. Charter

- The Process Improvement Team (PIT) was established to study the causes of hand, wrist and arm injuries while performing mechanical cleaning.
- The following stages of construction were analyzed:
  - Sub Assembly
  - Assembly
  - On-Block
  - On-Board
  - Blast Pit

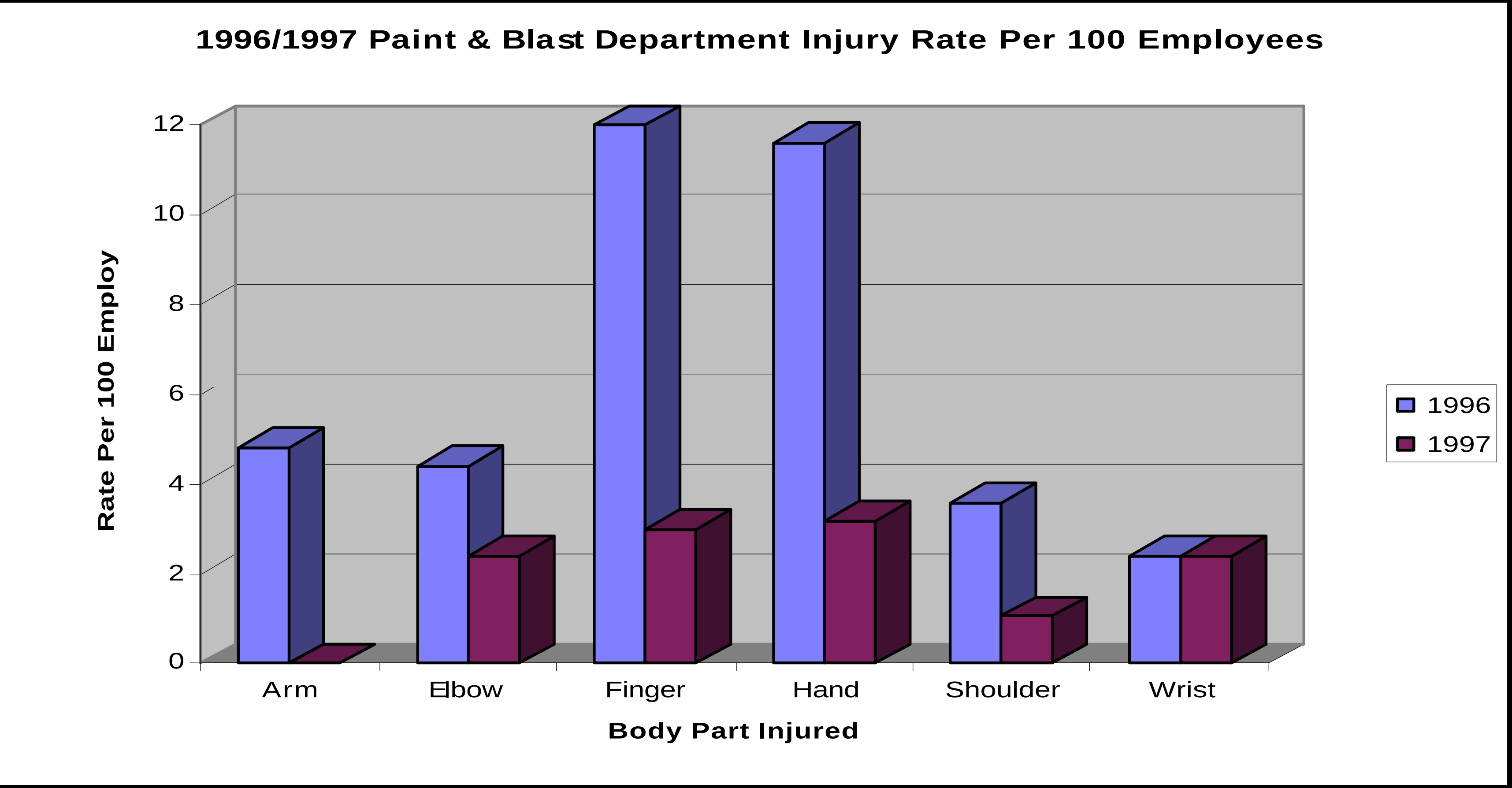
Paint & Blast Department Action Plan

- Reviewed 1994-1997 workers'comp. data
  - injuries vs. years of service
  - injuries by age group
  - body part injured
  - repetitive injuries by type
- Reviewed First Report of Injury from safety dept.
- Brainstormed ideas

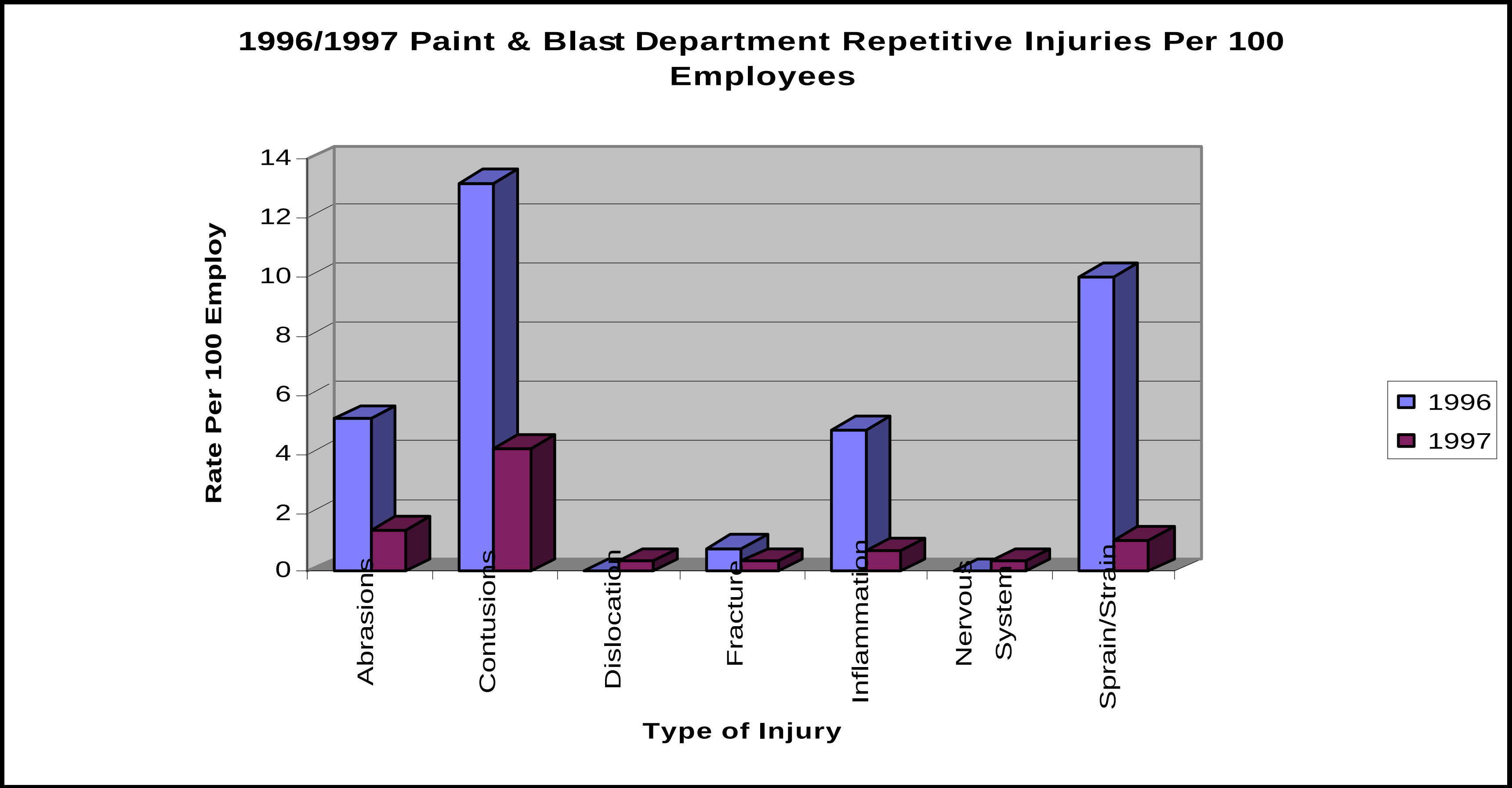
  23 ideas selected

  6 areas chosen for study
  - Weighted vote on all priorities

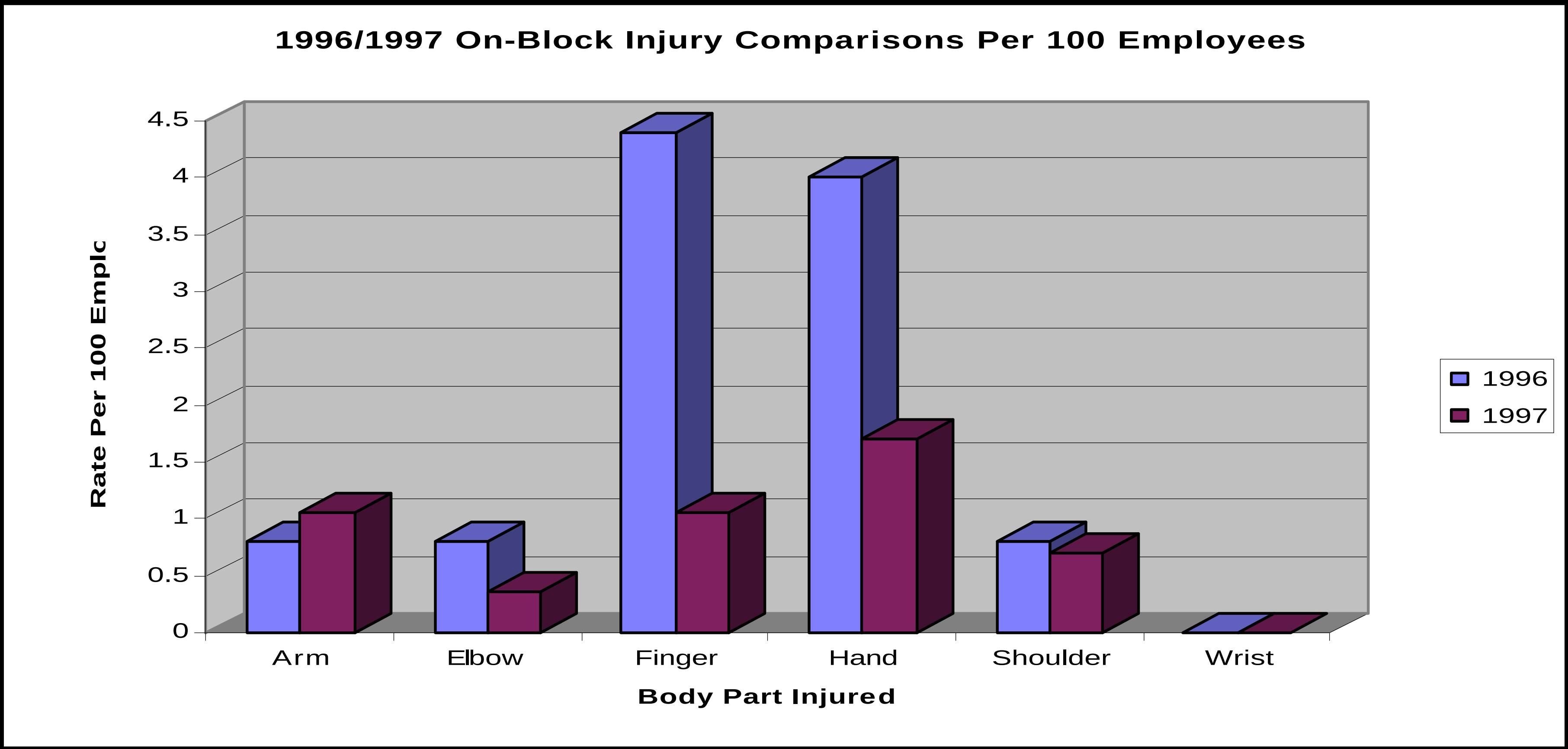
Paint & Blast Department



Paint & Blast Department



Paint & Blast Department



Paint & Blast Sub PIT Action Plan

- Conduct employee interviews
  - employees with hand/arm/wrist injuries
- Conduct observations
  - proper vs. improper handling techniques
  - ergonomics
- Review of power tools & equipment
  - buffers & grinders
  - gloves
  - abrasives
- Review mechanical cleaning process

Paint & Blast Department Buffer/Grinder Issues

Old Tool

- Three shift operation
- Manufacturer redesign
- Grease/bearing issues
- Improper tool usage
- Icing on buffers
- Wire wheels/danger
- Buffer/Grinder too large

New Tool

- Lightweight
- Ergonomic **Handles**
- Faster speed
- Durability
- Smaller design

Paint & Blast Department Abrasive Issues

- Different abrasives needed with new equipment
  - Lighter abrasives to match new buffers/grinders
  - Better abrasives provide less time of equipment usage for employees
  - 5 degree req'd instead of 15 degrees
  - Light weight back-up pads
- Would eliminate two steps from current process
- Longer usage than current abrasives

Paint & Blast Department Power Tool Training

- Norton Abrasive Company
- Mandatory for any industry that uses abrasives
  - Two day training sessions
  - All production shifts involved
  - 20 painters & blasters per class

Paint & Blast Department Glove Issues

- Existing Equipment
  - NASSCO supplied
  - Cotton
  - Leather
  - Other Options
  - Safeguard Technologies
  - Customized design
  - Therapy Specialist support

- Requirements
  - Waterproof
  - Cold/thermal insulation
  - Long life/durability
  - Comfort/fit
  - Anti-vibration
  - Non-slip surface
  - Ergonomic design
  - Wrist support

Paint & Blast Department Spray Equipment

- Equipment
  - Airless guns
  - Conventional guns
  - Electrostatic guns
  - Air-assisted airless guns
  - HVLP guns
  - Air-assisted electrostatic guns
  - Plural component units
- Compliance Issues
  - Transfer efficiency
  - Solvent usage
  - High solids paints
  - Waste reduction
- Costs
  - Equipment costs
  - Compliance costs

Paint & Blast Department Compliant Spray Equipment

- Electrostatic
  - Principles
  - Primers & metallic coating
  - Waterborne coatings
  - Compatible paint solvent
  - Versatility
  - Operator comfort, ergonomic considerations

Paint & Blast Department Compliant Spray Equipment

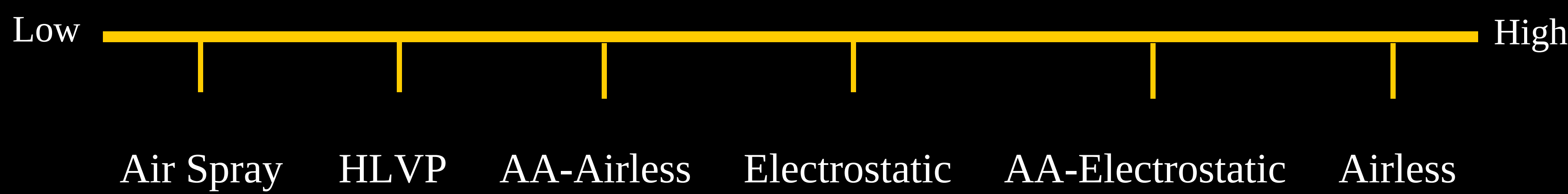
- Electrostatic usage areas
  - Exterior surfaces; bulkheads, decks, side shells, interior storage spaces, cargo areas, etc.
- Air-assisted airless usage areas
  - In all areas where current usage of airless guns are used

Paint & Blast Department Compliant Spray Equipment

- High volume low pressure guns
  - Can be used in areas where current usage of conventional spray is used
- Air-assisted airless electrostatic guns
  - More versatility than regular electrostatic guns to spray areas where Faraday cage effect is of concern

Productivity and Transfer Efficiency Ranking

Productivity



Transfer Efficiency

Paint & Blast Department Compliant Spray Equipment

- Plural component units usage and benefits

  -Some restriction on location & placement

  -Use in immediate areas of paint operation

  – Reduce manpower required to replenish spray pots
  – Utilizes less paint
  – 60% solvent reduction
  – Less space required
  – 50-70% more efficient

Paint & Blast Department

- Transfer efficiency rates:
  - Electrostatic 45-75%
  - AA-Airless 70%
  - Airless 20-40%
  - Conventional 15-30%
  - HVLP 50-75%
  - AA-Electrostatic 70-90%

Paint & Blast Department
Eye Injury Issues

- High frequency of first aid injuries
- Usage of full face cartridge respirators vs. goggles and eye glasses
- Reduced set-up by 30 minutes per painter
- Reduced safety hazards because fewer airlines attached to employee
- Major contributor eye injury reduction in department

Paint & Blast Department Accomplishments in 1997

- Generated cost savings of $1.2M
- Repetitive motion injury reduction of 87%
- On-block injury rate reduction of 55%
- No compensation cases for eye injuries
- Design of new anti-vibration glove
- Lighter, ergonomically improved power tools for paint & blast department
- Reduction of CTD’s by 70%

Electrical Sub PIT

- Team Membership
  - Team Leader
  - Safety Representative
  - Production Supervisors
  - Working Foreman
  - Leadperson

Electrical Sub PIT Charter

To analyze the causes of sprain and strain injuries among electrical employees and to develop methods of prevention

Electrical Sub PIT
Action Plan

- Brainstorming to determine
  - Root cause analysis
  - Aggravating conditions that contribute to sprain and strain
  - Identify internal and external factors
- Reviewed research material
- Reviewed workers' compensation and safety department data

Electrical Sub PIT Brainstorm Results

- Root causes of sprain/strain injuries
  - Surge of effort
  - Beyond range of motion
  - Biomechanics
  - Diminished range of motion with age

Electrical Department Analysis

- **External Factors**
  - Outside distractions
  - Emotional problems
  - Lack of sufficient rest
  - Lack of training
  - Body size
  - Pre-existing medical conditions
  - Sedentary lifestyle, etc.
- **Internal Factors**
  - Cable pulling
  - Lifting objects
  - Extended reaching
  - Working in awkward positions and cramped spaces
  - Prolonged effort

Electrical Sub PIT
Action Plan

- **Workplace issues:**
  - Inaccessibility of work spaces
  - Design issues
- **Ergonomics**
- **Equipment**
- **Training**
- **Employee hiring process**

Electrical Sub PIT
Action Plan

- Worksite study of cable crew
- Interviews
- Observations
- Questionnaire
- Stretching program

Electrical Department Results

- New Cable Puller
  - Assisted in manufacturer with design for shipboard use
  - Elimination of individuals needed to pull cable
- Implemented job rotation
- Ergonomic Training
  - Therapy specialist
  - Fisher Safety E.L.A.T.E. Training Program
  - Industrial Hygienist

Electrical Department Results

Back Belt Study

- No injuries reported among each of the test group
- Airbelt is a much better back brace for lifting and pulling
- Training and awareness the key to a successful program

Back belts don’t prevent injuries.
Properly trained employees do, with combination of back belt and back training

Electrical Sub PIT Accomplishments

- Cable crew injury rate decreased:
  - 18.2% in 1996
  - 3.6% in 1997
  - 2.4% current in 1998
- Cable crew injury cost decreased
  - $170,000
- Electrical dept. injury rate decreased:
  - 2.45% in 1996
  - 0.5% in 1998
- No workers' comp cases for electrical dept. in 1998
- Additional dept. cost decrease
  - $18,000

Electrical Sub PIT
Additional Accomplishments

- Man hours savings for 1 puller: 22,888/yr.
- Return on investment for cable puller:
  - $801,064 (for one puller)

By eliminating a process, at-risk work practices are eliminated and increased efficiencies are realized

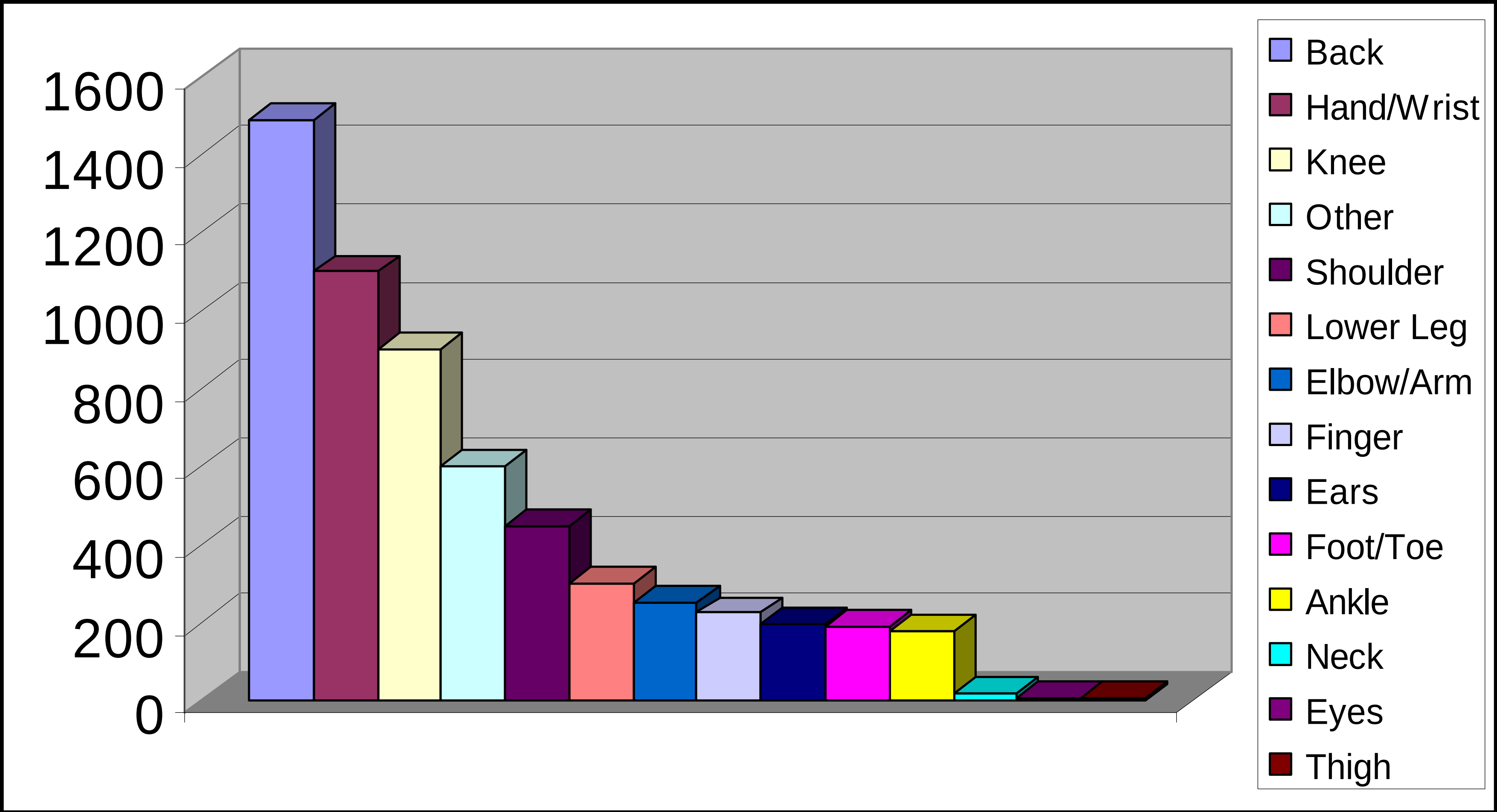
Steel Erection Sub PIT

- Team members
  - Five hourly workers
  - Facilitator
  - Department Manager
  - Project engineer
  - Engineer

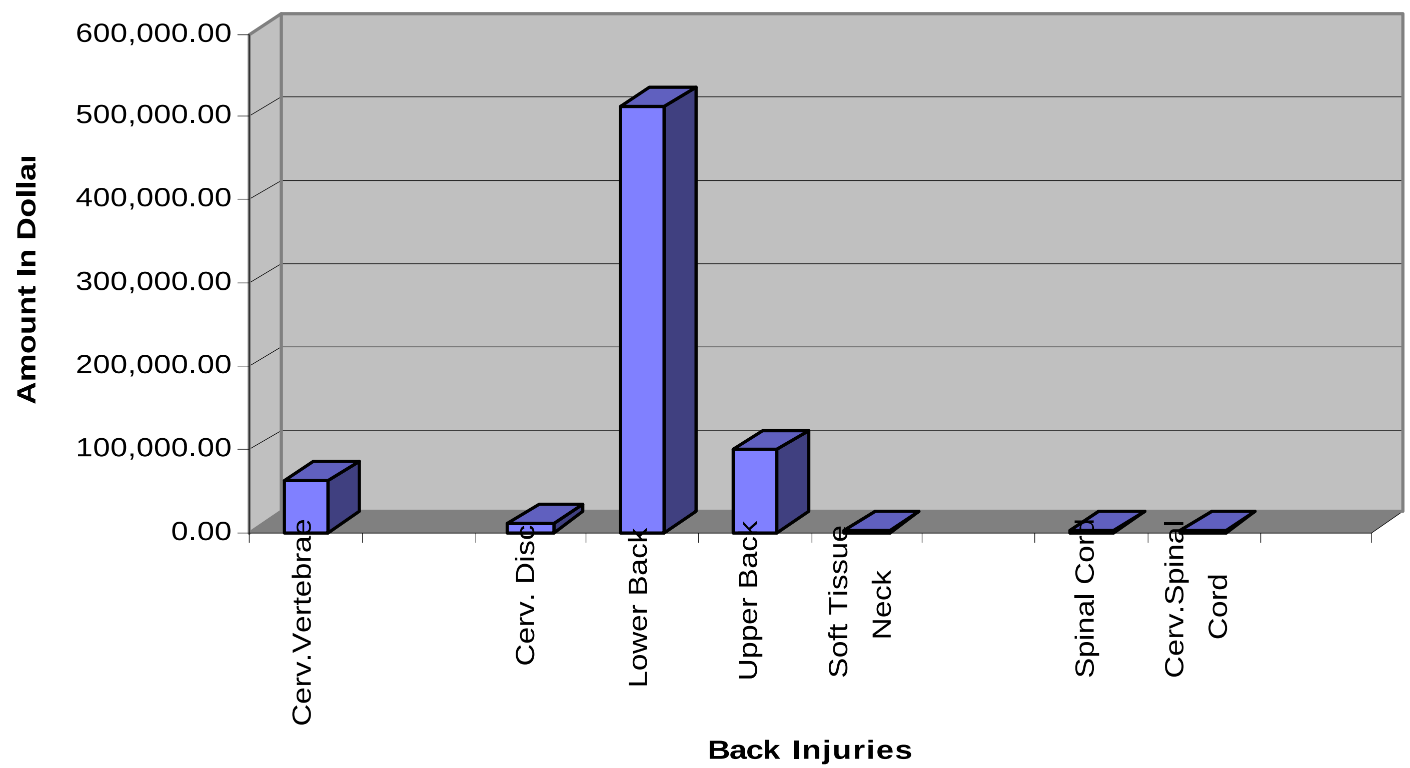
Team Charter

- Review injury data from 1995 to present
- Select re-occurring injury
  - Causes pain and suffering
  - Significant cost impact on the company
- Analyze causes of injury
- Develop recommendations to reduce injury
- Assist in the implementation of recommendations with co-workers

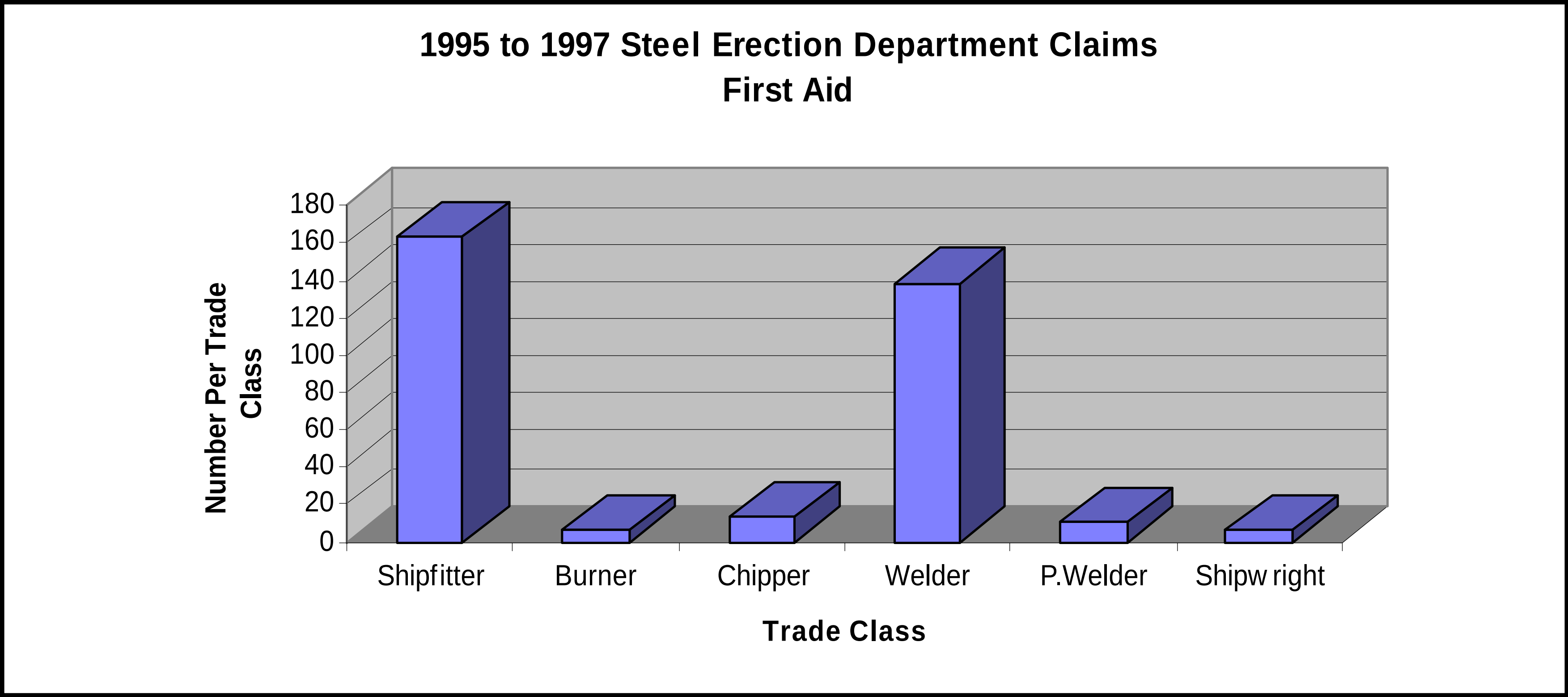
Steel Erection Injury Costs 1995-1996



Steel Erection Back Injuries by Type 1997



Steel Erection



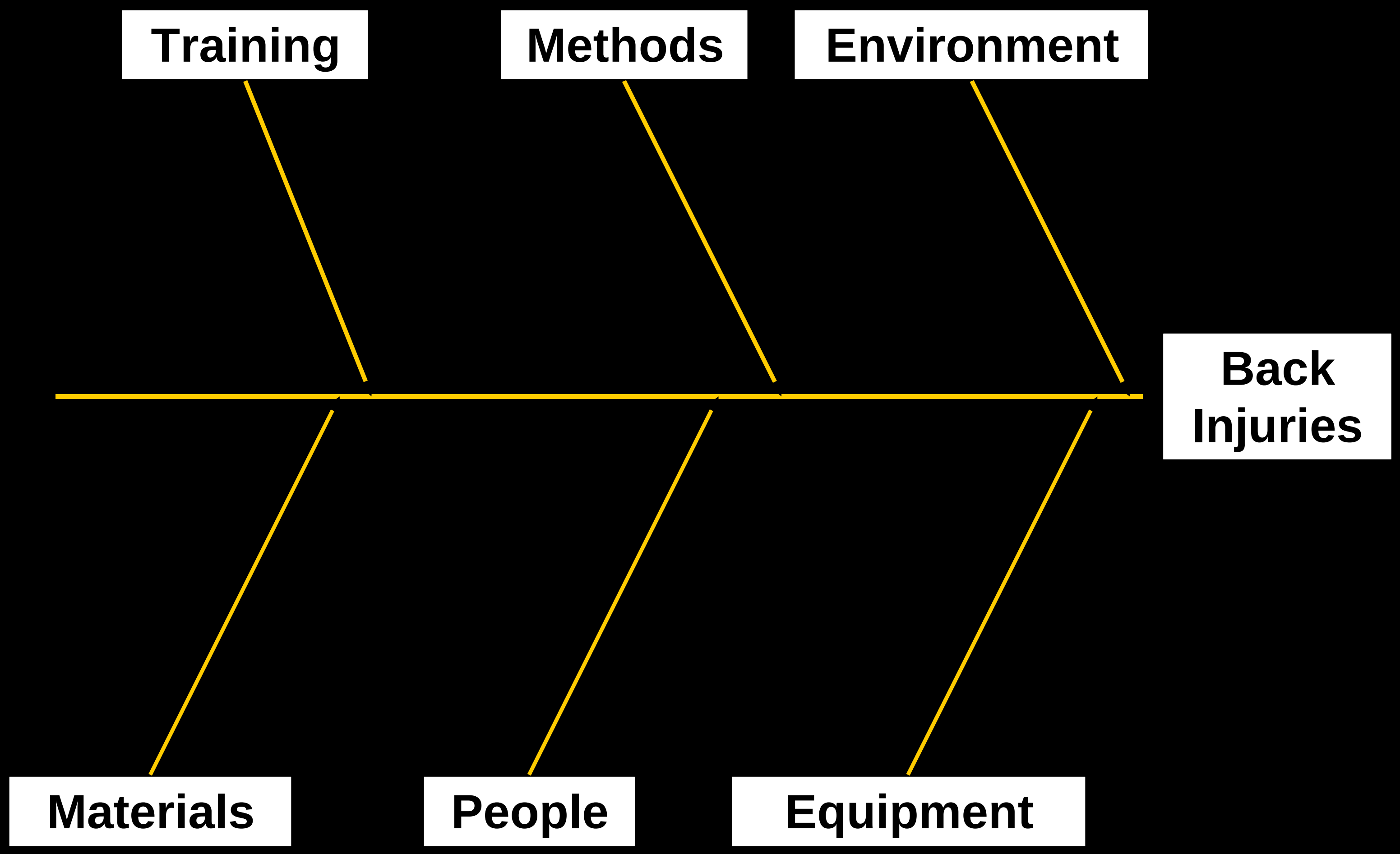
Tools Used

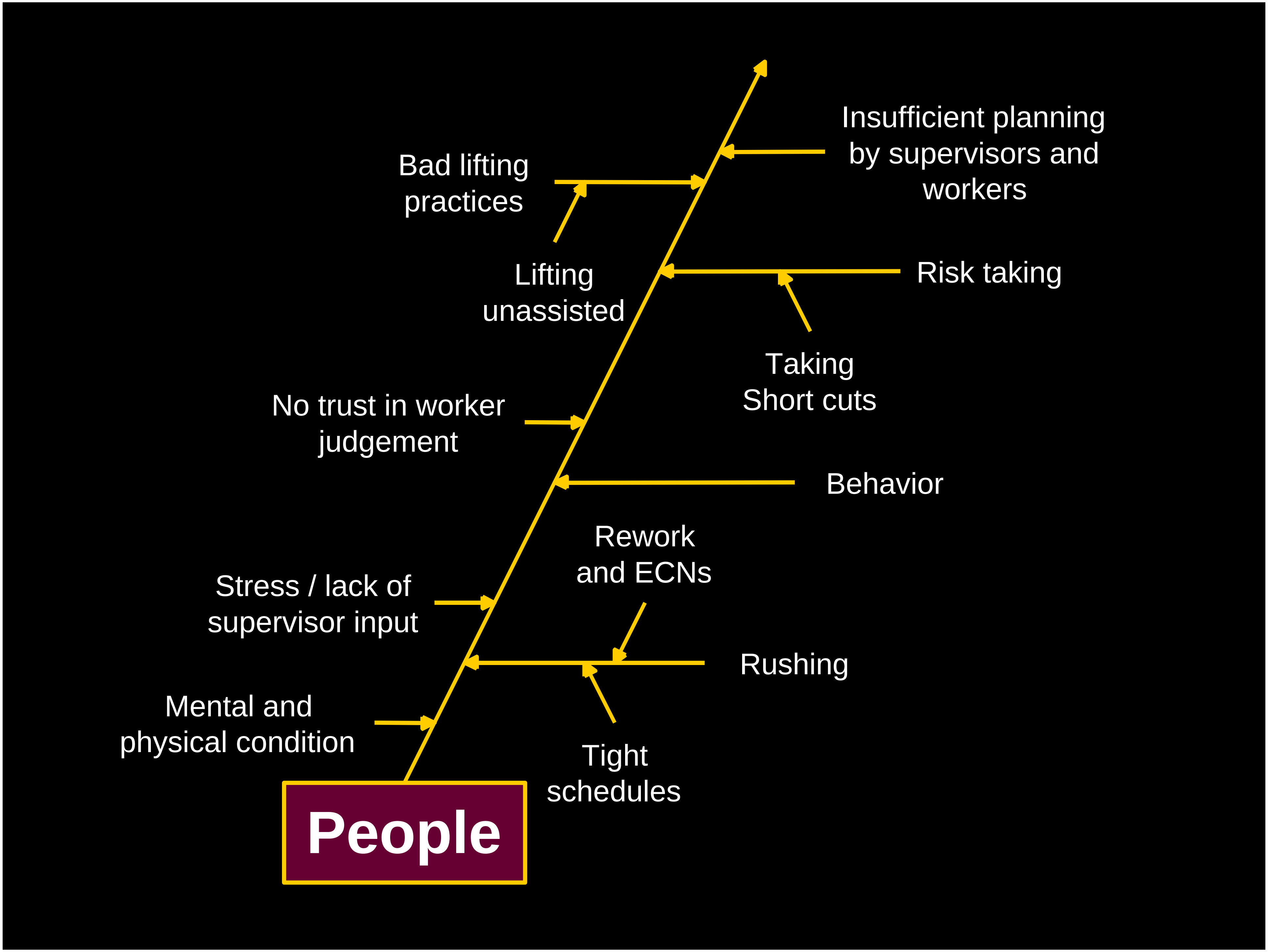
- Job hazard analysis
- Cause and effect diagram
- Behavioral observation and feedback system
- Observation data sheet

Process Used

- DO IT
  - Define
  - Observe
  - Intervene
  - Test

Cause and Effect Diagram




Insufficient planning by supervisors and workers
Bad lifting practices
Lifting unassisted
Risk taking
Taking Short cuts
No trust in worker judgement
Behavior
Rework and ECNs
Stress / lack of supervisor input
Rushing
Mental and physical condition
Tight schedules
People

Observation Checklist

Observer ___________________________		Date_____
Location ___________________________		
	Safe	Unsafe
Bend knees and use legs		
Keep back straight		
Keep load close to body		
Lift slowly and smoothly		
Get help with heavy loads		
Use tools/equipment to lift		
Build a bridge		

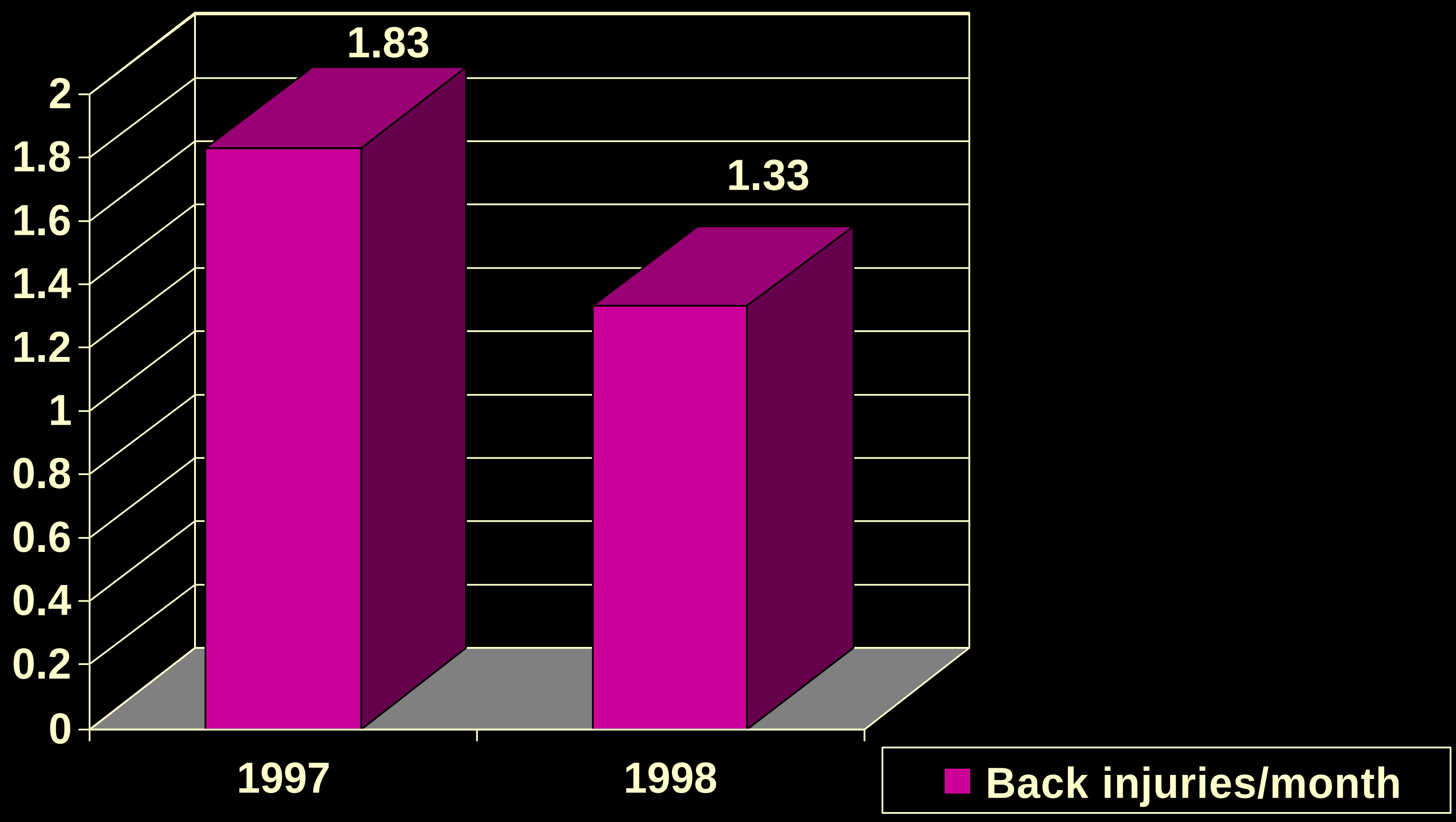
Intervention Methods

- Photos
  - Safe lifting practices
  - Unsafe lifting practices
- Presentation
- Sub PIT members conducted meetings at each site
- Proper lifting training
  - Video
  - Peer conducted

Observation Results

	7/97 - 9/97	12/97 - 3/98
	Percent Safe	
	Pre-Intervention	Post-Intervention
Bend knees and use legs	44%	79%
Keep back straight	47%	69%
Keep load close to body	56%	70%
Lift slowly and smoothly	54%	76%
Get help with heavy loads	60%	71%
Use tools/equipment to lift	51%	73%
Build a bridge	N/A	84%
Cumulative Total	51%	71%

Steel Erection Back Injury Data



Recommendations

- Expand PIT to other departments & gain cooperation of fellow workers
- Incorporate back injury prevention into new hire orientation
- Utilize experience from this PIT toward the implementation of company-wide behavior-based safety program

Benefits

- Using ergonomics to reduce lower back injuries, hand, wrist and shoulder injuries.
- Better tools and equipment
- Training
- Techniques for effective observation
- Effective team building skills

Summary

- Different Approach
- Team Structure
- Training
- Management Support
  - Cost
  - Time & Effort

ACHIEVING A TOTAL SAFETY CULTURE THROUGH BEHAVIORAL OBSERVATION AND FEEDBACK

NSRP WORKSHOP

Project #N8-96-3

1998

National Steel and Shipbuilding Company

Company Demographics

- National Steel and Shipbuilding Company is a major ship design, construction and repair company
- Modern industrial facility encompassing 147 acres
- Workforce of approximately 4,500
  - three levels of direct supervision
    - working foreman (bargaining unit employee)
    - production supervisor (salaried employee)
    - general supervisor (salaried employee)

Workshop Objectives

- Understand the importance of using a behavioral science approach in creating a total safety culture
- Identify the components of a behavioral observation and feedback process
- Practice an observation
- Practice giving and receiving feedback

Agenda

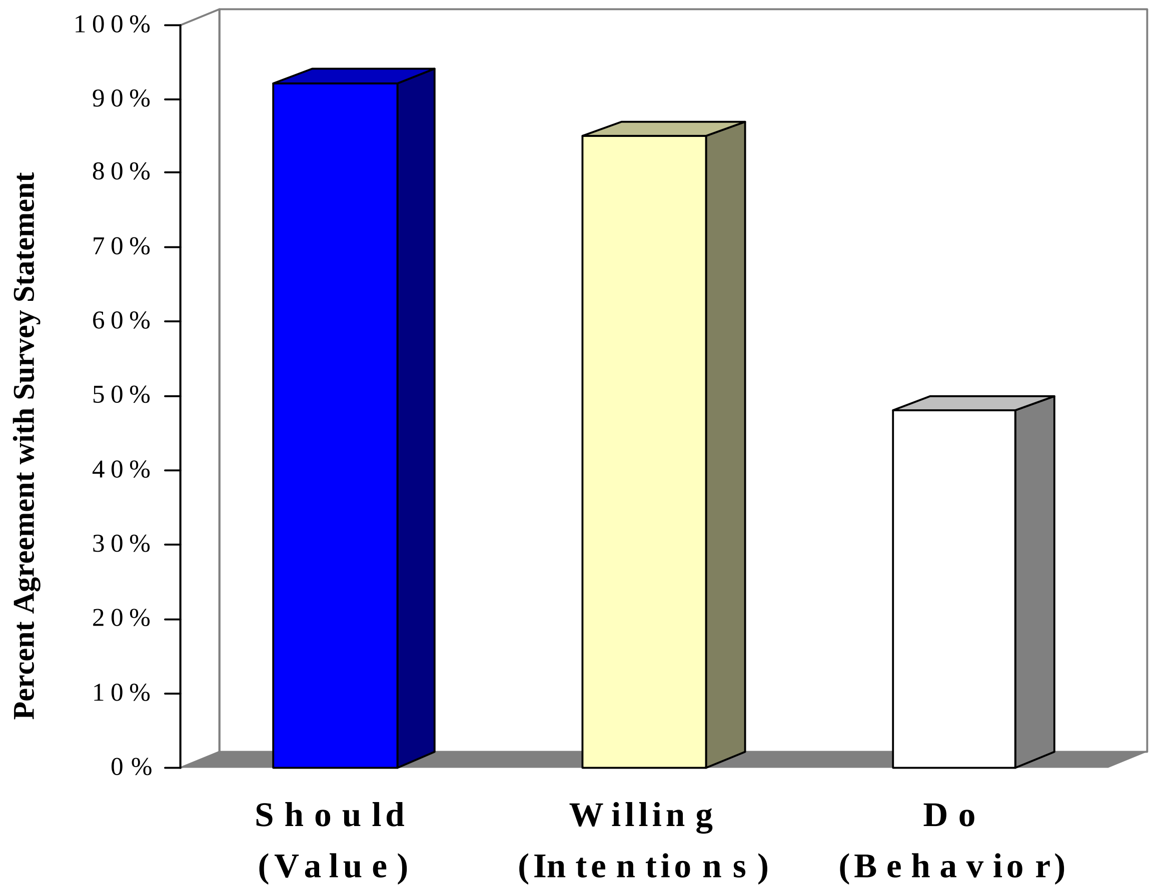
- A Total Safety Culture Overview
  - What it is
  - Why it is important
- Motivation - how it affects you
- The Observation and Feedback Process
- Supervisor Responsibilities
- Giving and Receiving Feedback
- NASSCO’s Implementation Approach

The Characteristics of a Successful Total Safety Culture

- Safety is held as a value by all employees
- Each employee feels a sense of responsibility for the safety of their co-worker as well as themselves
- Each employee performs “Actively Caring”
  - Each employee is willing and able to “go beyond the call of duty” for others

Values, Intentions and Behaviors

Cautioning co-workers about performing unsafe acts

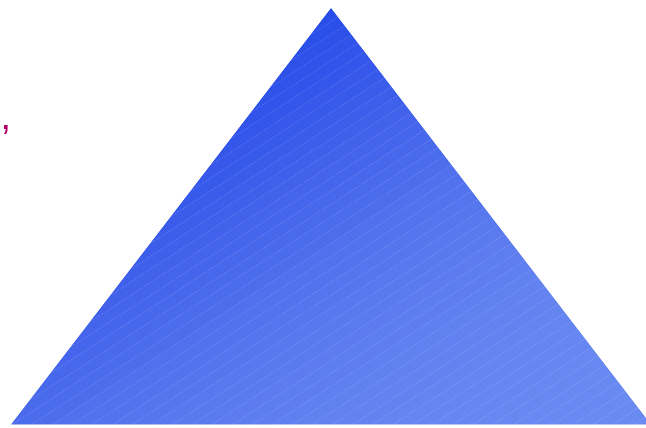


Safety Triangle

1

Environment

Equipment, Tools, Machines, Housekeeping, Heat/Cold, Engineering



2

Person

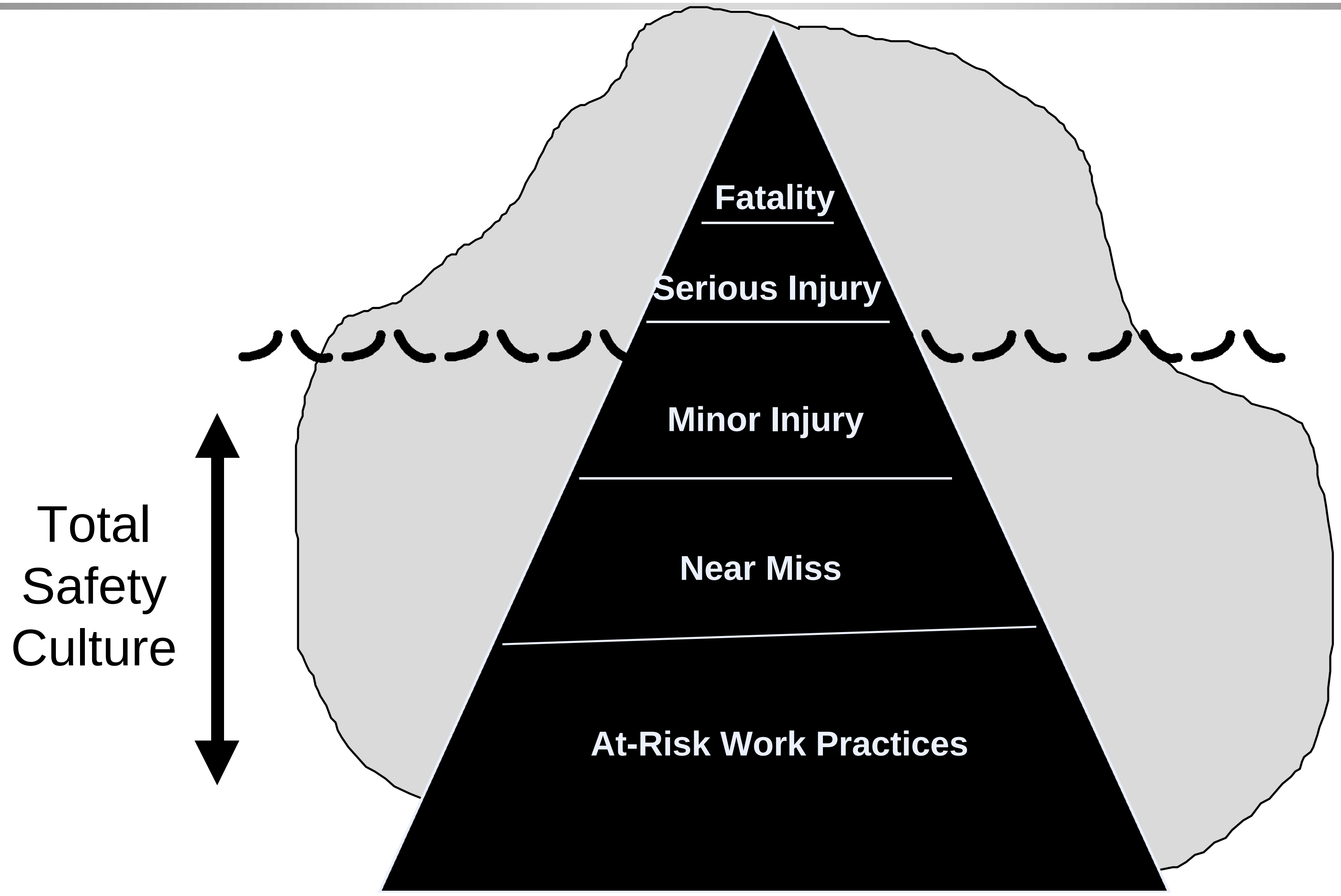
Knowledge, Skills, Abilities, Intelligence, Motives, Attitude, Personality

3

Behavior

Putting on PPE, Lifting property, Following procedures, Locking out power, Cleaning up a spill, Sweeping floor, Coaching co-workers

Focus: Accident Prevention



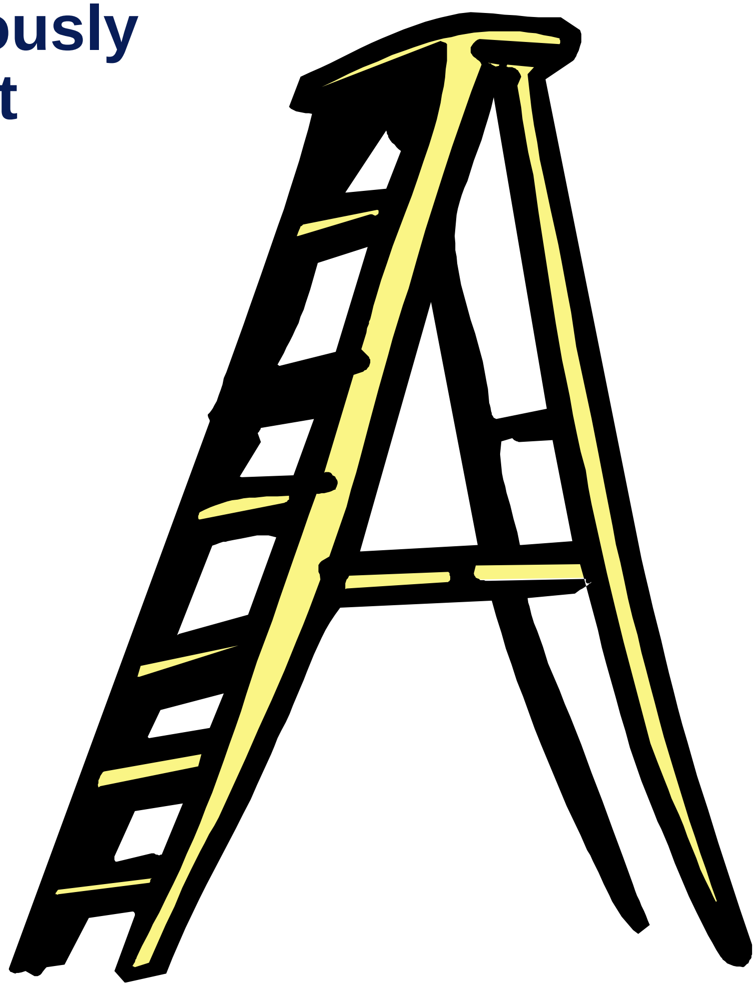
Developing Safe Habits

Unconsciously Competent

Consciously Competent

Consciously Incompetent

Unconsciously Incompetent



Direction Is NOT Enough

Direction

Motivation

Behavior

ABC Model
What Motivates Behavior?

Activators

Guides, directs , or triggers the behavior

Signs

Policies

Directive Feedback

Training/demonstrations

Goal Setting

Modeling

Lectures

Behavior

Actions

Driving the speed limit

Putting on PPE

Locking out power

Using equipment guards

Giving a safety talk

Cleaning up spills

Coaching others about safe work practices

Consequences

Motivates the future occurrence of the behaviors

Self-approval

Supervisor approval

Reinforcing feedback

No injury

Pizza Lunch

Co-worker approval

Thank You

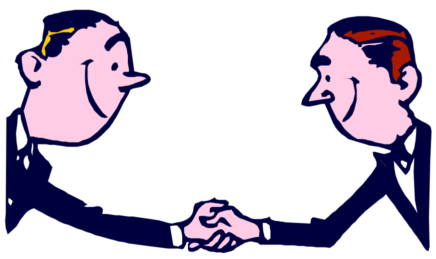
Feedback Influences Work Practices

- Reinforcing feedback increases desired work practices

- Corrective feedback decreases undesirable work practices

Functions of Feedback

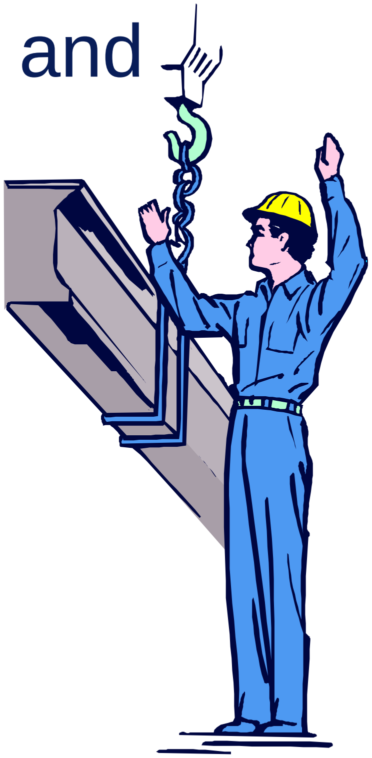
- Provides needed information
- Provides social support:
  - co-worker support and acceptance
  - manager/supervisor approval



Observation and Feedback Process

Observation and Feedback

- Observation sheet guides the observer
- Observer immediately provides feedback
- Observation sheets collected, compiled and graphed
- Information reviewed with employees
- Information analyzed for follow-up, and
- Problem solving for targeted areas



TSC Data Collection

- Number of observations per week
- Total % of safe work practices per week
- % of safe work practices by category per week
- % of safe per category

NASSCO Observation and Feedback Process

- Tailored to meet the needs of each department:
  - work practices to target
  - design of the observation sheet
  - use of the observation sheet
  - processing and review of data
  - follow-up

Interaction
More Important Than Data

- There is no “best” approach
- True benefit is in the safety focused interaction
- Feedback should occur whenever an opportunity arises

Observation and Feedback Exercise

Sample Definition Sheet

1.0 Housekeeping (Safety Manual Reference 3.7 CH#5)

- 1.1 Trash, scrap (slag) disposed of
    - Plastic bags/skip tubs/scrap tubs readily available
    - Hazardous material is in proper secondary container and correctly identified with NASSCO product label
- 1.2 Spills, water, and dry absorbent are cleaned up as appropriate
    - There are no oily or slippery substances on the floor
        - Water is cleaned up appropriately for the work area
- 1.3 Material is properly organized
    - Material is neatly stacked when not in use
    - Material lanes not used as storage areas
        - Old and/or obsolete material is disposed of or removed from ship
- 1.4 Walkways are clear and identified
    - Scaffold and staging are considered walkways and should be cleaned as you work
- 1.5 Lines, leads hoses properly routed
    - Dead leads removed
        - Temp services located/available in safe, practical location
        - Does not pose a trip hazard
- Electrical power leads not in water

Sample Observation Sheet

☐ Observation Interrupted * SIG Follow-up * ☐

NASSCO MASTER OBSERVATION SHEET

Observer ___________________________ Badge # ___________

	Safe	At-Risk	NA	Observer Comments
1.0 Housekeeping				
1.1 Trash, scrap, (slag) disposed				
1.2 Spills and water are cleaned up as appropriate				
1.3 Work area is properly organized				
1.4 Walkways are clear and unobstructed				
1.5 Lines, leads, hoses properly routed				
2.0 PPE (Proper PPE and in good condition)				
2.1 Eye and face protection				
2.2 Hand protection				
2.3 Hearing protection				
2.4 Hard hat				
2.5 Shoes and clothing				
2.6 Respirators				
2.7 Other (knee pads, leathers)				
3.0 Body Use and Positioning				
3.1 Proper lifting techniques, gets help if needed				
3.2 Proper body mechanics				
3.3 Walking/climbing/caution on slippery surfaces				
3.4 Line of fire/pinch points				

Video Illustrates Important Points

- Employees still perform at-risk practices
- Observers may notice only a few of the safe and at-risk practices
- Different observers note different practices
- Safe and at-risk can be subjective judgments
- We notice at-risk acts more than safe acts
- We become more systematic with observation sheet
- We improve with practice

Exercise: Video

- Locate video worksheet
- While viewing video, complete the worksheet
- Prepare to share your answers with the class

Guidelines for Receiving Feedback

- Be open and receptive
- Think BEFORE you react
- Be objective/not defensive
- Avoid taking a position
- Ask for specifics
- Actively LISTEN
- Work together on potential solutions
- Reach an agreement
- Say thank you

Key Points of TSC

- Creating a Total Safety Culture requires:
  - Safety is held as a value by all employees
  - Each employee feels a sense of responsibility for the safety of their co-worker as well as themselves
  - Each employee performs “Actively Caring”
    - Each employee is willing and able to “go beyond the call of duty” for others
  - An observation and feedback process which reinforces safe behaviors and provides corrective feedback for at-risk work practices

NASSCO's Implementation Approach

Total Safety Culture

Salaried Supervisor's TSC Responsibilities

- Near Miss Reporting
- Accident/Incident Reporting
- Housekeeping
- Observation and Feedback

Observation and Feedback Process

- Supervisors attend 12 hours of TSC training
- Accompany hourly work crews to their 4 hour TSC training
- Conduct 2 observations daily
  - give immediate feedback to employee
  - complete comments section of observation sheet indicating result of feedback session
  - turn in observation sheet for data compilation
- Share information with employees during 5 minute morning meeting
  - overview of observations
  - feedback from Site Implementation Group (SIG)

Area Site Implementation Group

- Supervisors within stage of construction/department
  - representing trades and shifts
  - leader, note taker and time keeper roles selected
- Role models and champions for TSC
- Develop customized process for their area
- Meet weekly to:
  - assess area progress
  - analyze data
  - take action on at-risk items
  - develop action plans
- Provide feedback to supervisors, employees, Area SIG sponsor

Central SIG

- Area SIG leaders meet monthly to:
  - share TSC best practices throughout yard
  - provide resource and support for each other
  - share lessons learned
  - brainstorm solutions for problem situations
  - recommend changes to processes or policy to Steering Committee

Lessons Learned to Date

- Successes
  - involving SIG members in making presentations during the training sessions create their early buy-in
  - improved communication between employees and supervisors
  - better awareness of at-risk conditions; action being taken to correct
  - cooperation between areas to resolve at-risk conditions
- Improvements made
  - restructure to move the decision making and ownership to the lowest level possible
  - include more safe and at-risk examples in training sessions using pictures and videos of employees working
  - streamlining data collection and reporting (this is a continuous effort and one we need help with)

Supporting Structure

The following pages give an outline of our overall process key responsibilities

Area SIG Sponsor

- Provide support and resources to Area SIG
- Ensure on-going operational success of TSC process
- Review, evaluate and approve recommendations from Area SIG
- Serve on Steering Committee

Steering Committee Charter

- Review, evaluate and approve as appropriate recommendations from Central SIG
- Ensure ongoing operational success of Total Safety Culture Process
- Oversee SIG's to ensure consistency of application of TSC principles
- Address all yard-wide safety related issues generated from a Steering Committee member or other external source
- Isolated issues referred back to the affected SIG for consideration and recommendations under the normal SIG process
- Members are Area SIG sponsors
- Members meet monthly; special meetings may be called by the Steering Committee Chairperson, as needed

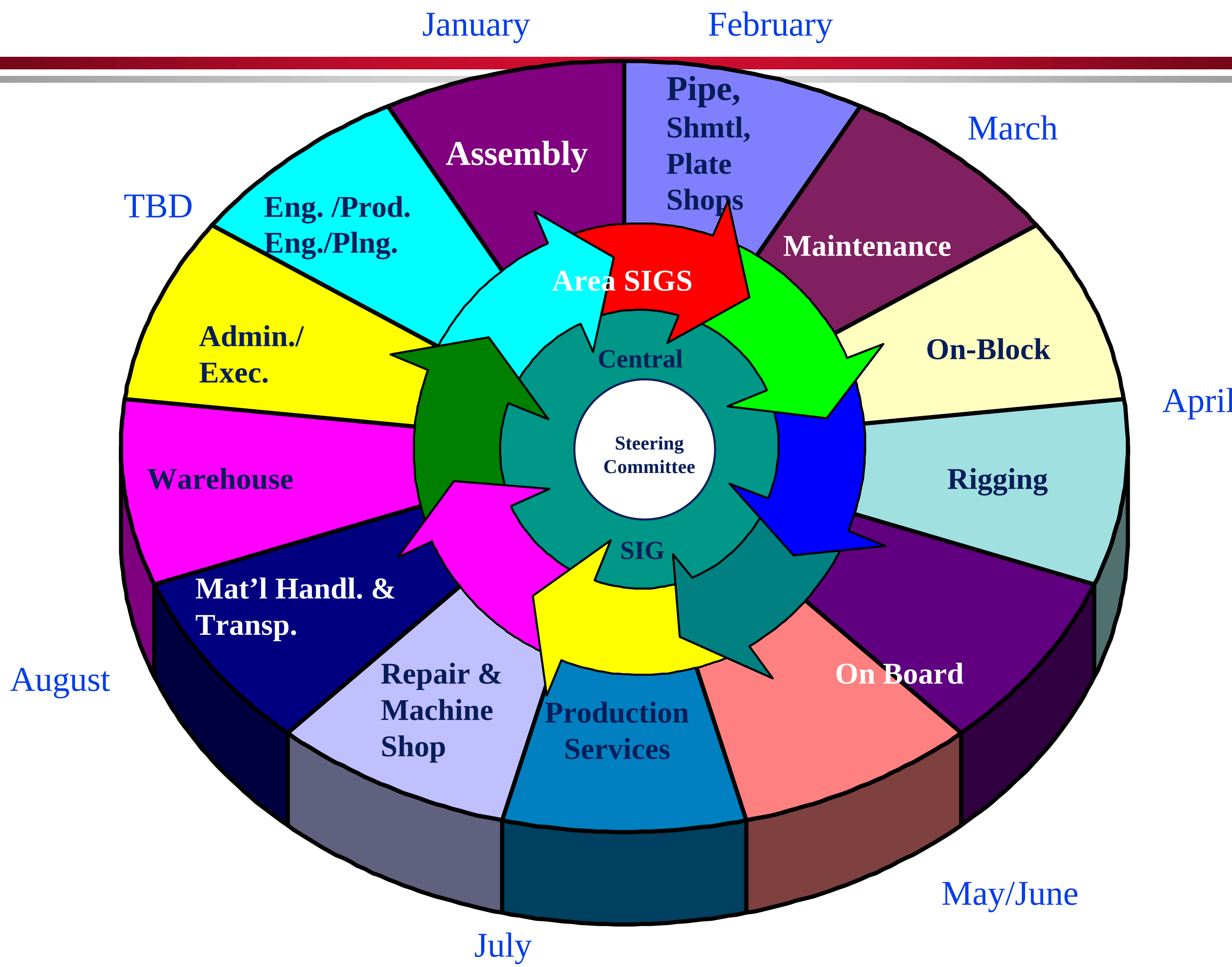
Management Sponsors

- Champion the yard-wide TSC process
- Steering Committee and TSC Coordinator report results
- Provide guidance and support for Steering Committee
- Liaison with Executive Staff

TSC Coordinator

- Oversight for all training activities and materials
  - Steering Committee
  - Supervisor
  - SIG
  - Employee
- Facilitate all SIG meetings
- Coordinate data collection and reporting
- Assess process effectiveness, recommend changes as appropriate
- Liaison with consultant

TSC Group / Area Breakdown



Computer Based Training Module

Application of Industrial Engineering Techniques to Reduce Workers Compensation and Environmental Costs

N8-96-3

Objective

- To provide a computer-based training (CBT) module on environmental awareness issues that impact the shipyard operation and production.
- Training to meet regulatory requirements
  - Cost effective, “JIT” Training

Problem Statement

- No cost effective method for environmental regulatory re-training
- Most training sessions impact:
  - Production man-hours
  - Instructor efficiency

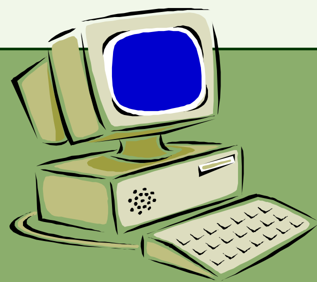
Solution

- Development of customized computer based training (CBT) module aimed towards shipyard specific training issues:
  - US Coast Guard, Clean Water Act, Clean Air Act

Potential Benefits

- Trainees can schedule the training at their convenience to meet individual needs
- Trainees can work at their own pace
- The module meets regulatory requirements
  - Can easily be modified to meet changing regulations
- Cost effective (requires no trainer)
- Training consistency

CBT Development



P-233, Windows NT
64MB Ram
6GB HD
Video Capture Card
Diamond Monster Video Card w/ 8MB
Smart & Friendly 426 External CD RW

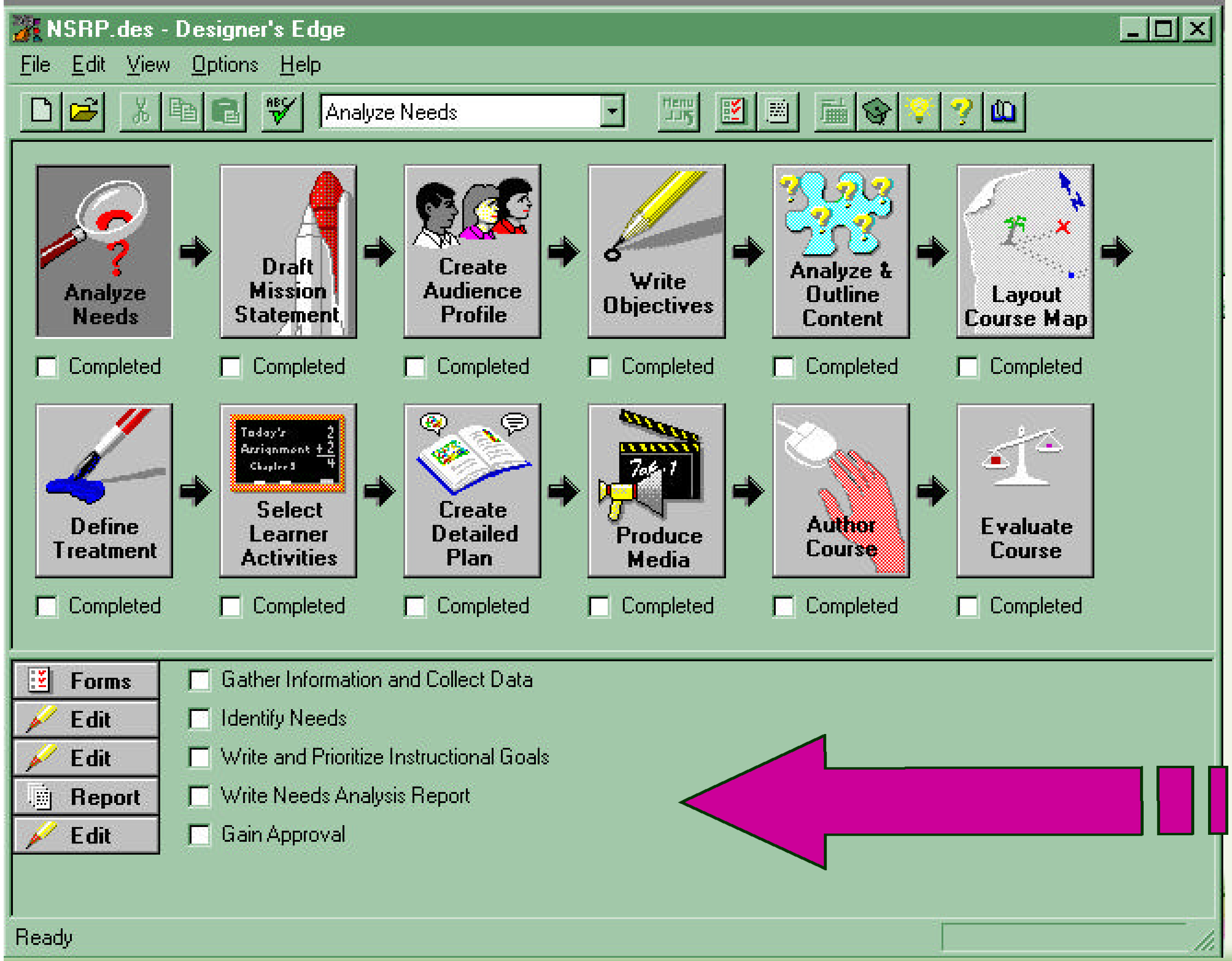
- Macromedia's Authorware Studio Suite
  - Complete studio: Authorware, Director, Xres, Backstage, Sound Editing
  - #1 in market
  - Automatic conversion feature for WWW
  - Many outside training courses, help groups, etc.

Designer's Edge Software

- A course writing tool from Allen Communication
- Takes Instructional Designer step-by-step through course writing procedures
  - Stand up training or CBT
  - Consistency
  - Thorough
  - Easily updated

Let's take a look!

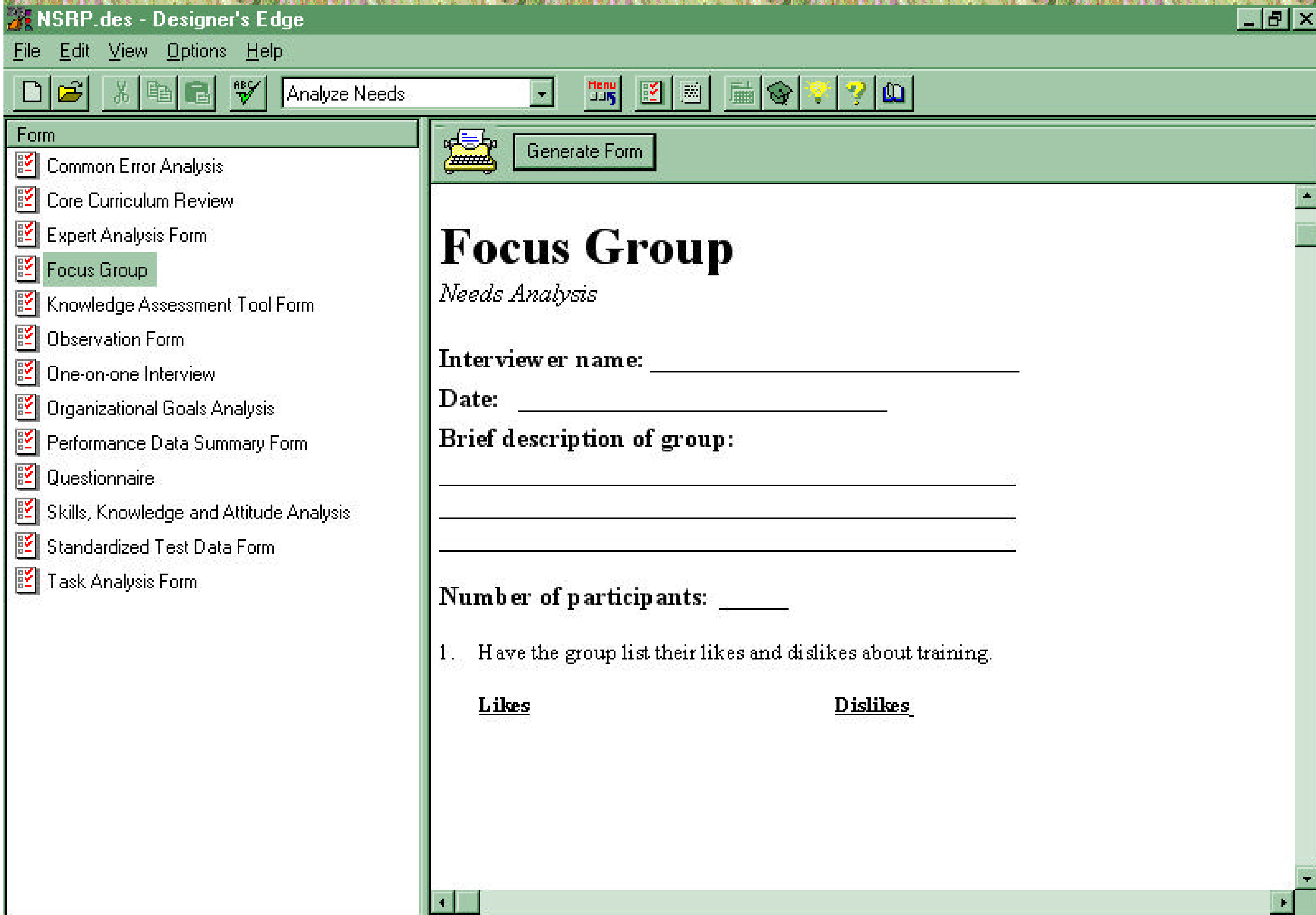
Designer's Edge Main Screen



The 12-step process that leads you through course designing, following ISD principles.

These are the sub-task items that need to be completed under the "Analyze Needs" icon.

Designer's Edge



Focus Group

Needs Analysis

Interviewer name: ___________________________

Date: ___________________________

Brief description of group:

____

____

____

Number of participants: _____

1. Have the group list their likes and dislikes about training.

Likes	**Dislikes**

2. Ask for recommendations to improve existing training. (Write down all comments)

3. What types of training do you like best? (Say the name of each training type aloud. Have the group raise their hands for any of training methods that they like--group members will probably respond to more than one training type)

Training Types	**Responses**
Instructor-led Classroom	
On-the-Job Training (OJT)	
Field Trips	
Video Tapes	
Workbooks	
Job Aids	
Computer-based Training	
Independent Study	
Study Groups	
Observing Others	
Simulations	
Other:	

4. What do you need to know to do your job well? (Make a list)

5. What do "expert performers" do that "novice performers" do NOT do? (Make a list)

6. What are the most common/frequent problems you face on the job? (Make a list, preferably one that all in the group can see.)

7. By vote, rank the problems from the most troublesome to the least troublesome.

<u>**Problem List (from most to least troublesome)**</u>	<u>**Rank**</u>

8. Tell me a "war story" about some of the most troublesome problems and how they affect your job performance. (Record any stories)

9. What is it about your job that changes the most? (List any answers)

10. What stays the same? (List any answers)

11. What tricks do you use to learn and remember something?

12. How do you and your co-workers feel about your jobs? Are there any attitude problems that may be affecting productivity? (Have a brief discussion and write a summary of how they feel about their jobs)

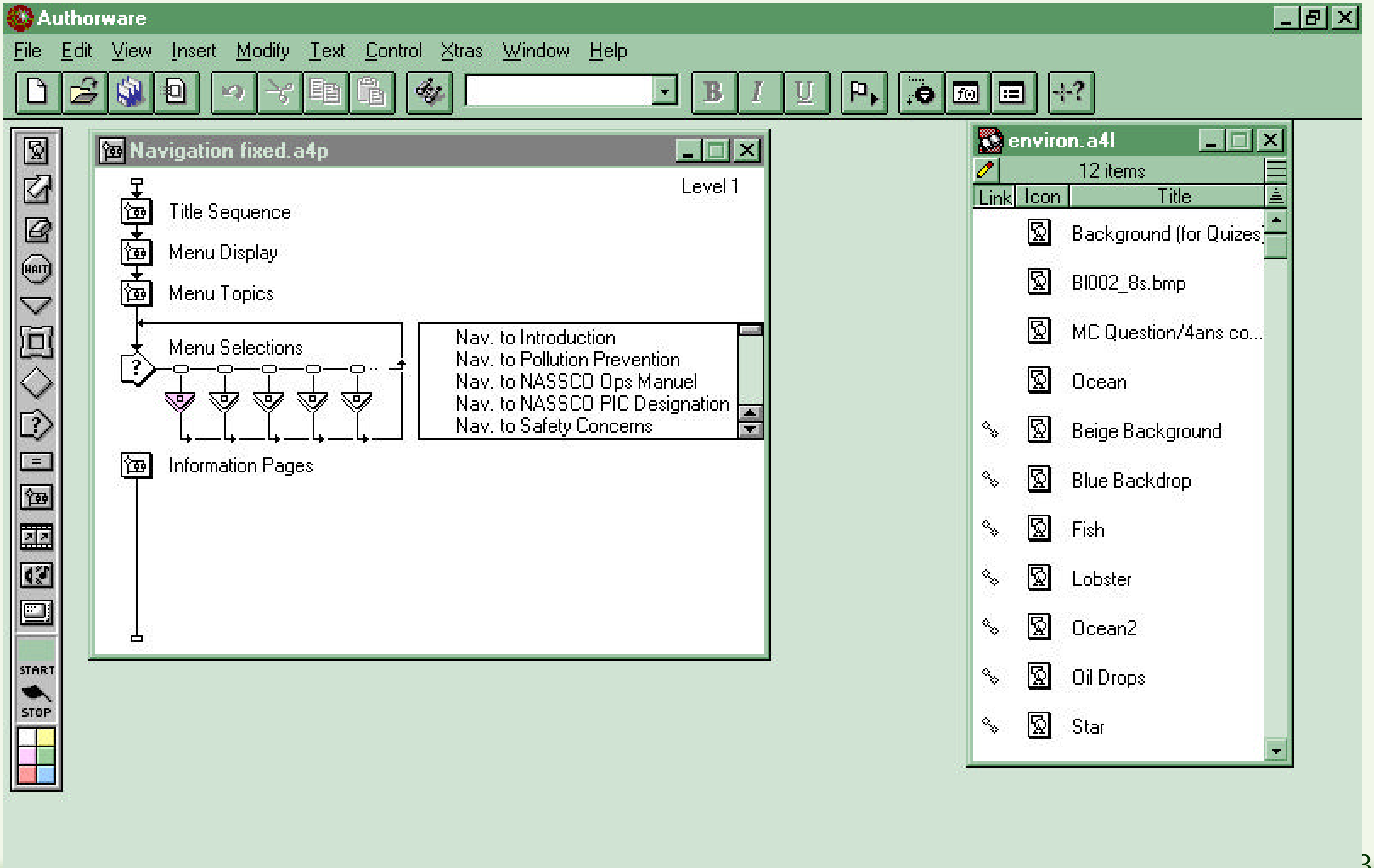
13. What do you like most about your job? (Make a list)

14. What do you like least about your job? (Make a list)

15. What motivates you to do your best work? (Make a list)

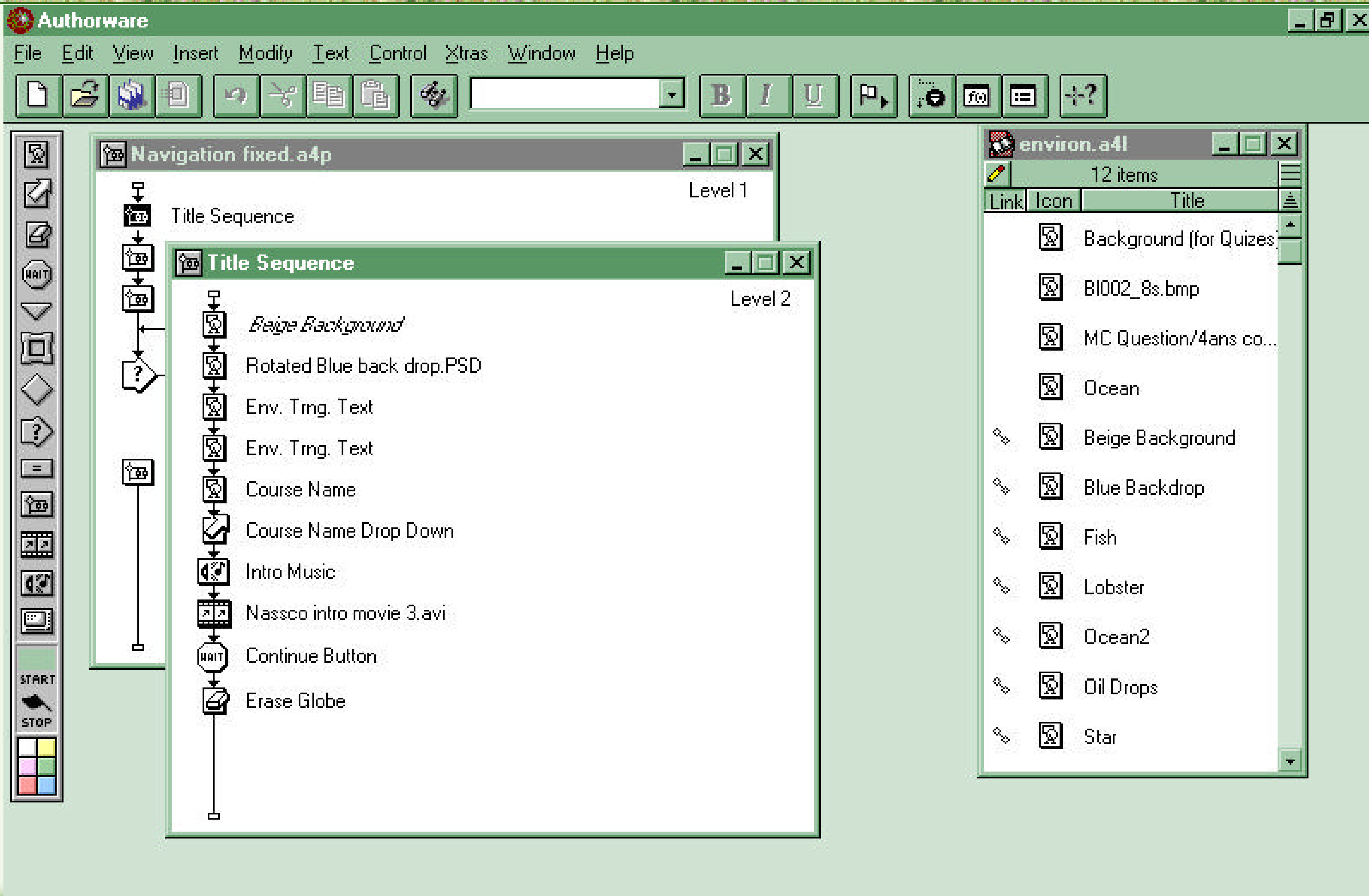
16. What would help you become more productive on the job? (Make a list)

Authorware



Authorware
File Edit View Insert Modify Text Control Xtras Window Help
Navigation fixed.a4p
Level 1
Title Sequence
Menu Display
Menu Topics
Menu Selections
Nav. to Introduction
Nav. to Pollution Prevention
Nav. to NASSCO Ops Manuel
Nav. to NASSCO PIC Designation
Nav. to Safety Concerns
Information Pages
START
STOP
environ.a4l
12 items
Link Icon Title
Background (for Quizes)
BI002_8s.bmp
MC Question/4ans co...
Ocean
Beige Background
Blue Backdrop
Fish
Lobster
Ocean2
Oil Drops
Star

Authorware


Authorware
File Edit View Insert Modify Text Control Xtras Window Help
Navigation fixed.a4p
Level 1
Title Sequence
Title Sequence
Level 2
Beige Background
Rotated Blue back drop.PSD
Env. Trng. Text
Env. Trng. Text
Course Name
Course Name Drop Down
Intro Music
Nassco intro movie 3.avi
Continue Button
Erase Globe
environ.a4l
12 items
Link Icon Title
Background (for Quizes)
BI002_8s.bmp
MC Question/4ans co...
Ocean
Beige Background
Blue Backdrop
Fish
Lobster
Ocean2
Oil Drops
Star
START
STOP

Notes from CBT slides

#6
The Authoring PC
P-233, Windows NT: Choose a good PC. Faster IS better.
64MB Ram: Important if you think you'll be digitizing video, or rendering graphics. Minimum RAM requirements 32MB.
6GB HD: You'll need the space! Especially important for digitizing video! I chose a SCSI model, allowing faster data transfer.
Video Capture Card: Allows you to transfer video from a camcorder or VCR to a digital format.
Diamond Monster Video Card: Good all-around card. The extra memory on card helpful for digitizing and rendering graphics.
Smart & Friendly CDR/RW: CD Recorder/Rewrite. Used to burn CD's for your library of projects. This brand is middle of the road in cost, excellent quality. I highly recommend it for anyone looking at a CDR or CDR/RW. Note: If you think you'll be burning a good quantity of CD's, purchase an external model. This type of equipment can get very hot, and you don't want that extra heat inside the case of your PC!

Macromedia Authorware Suite- *a Complete Solution*
Authorware: The main authoring program. Utilizes a flowchart technique to author, making it powerful, yet easier to use program.
Director: Another authoring program. The most powerful authoring tool of all. Director requires extensive training to use all features, and it's files can be imported into Authorware files.
Xres: A graphic authoring application.
Sound Edit: A sound file authoring or modifying application.
Backstage: Used for WWW page authoring.

#8
The Main Screen
The program utilizes 12 "steps" to design your training module.
•The upper half of main screen contains 12 large icons representing sequential steps to follow when creating your course.
•The lower half of screen contains icons and check boxes that pertain to each of the 12 steps. Use the check-boxes to give a "complete" status to each sub-task before proceeding to next step in process.

#9
Forms needed to gather information are included in D.E. The program will automatically generate your choice of form using your Word Processing application. All forms can be customized….or you can create your own.

#13
Authorware
•The larger window contains the basic course. Opening any of these "mapped" icons will show that there are multiple levels of programming contained within.

•The smaller window on the right contains a common library of graphic files that were used in multiple locations throughout the course. This library helps cut down on the size of your finished project.

#14

•Opening the Title Sequence mapped icon reveals the programming that went into the one screen of information.

Hazardous Waste Tracking Software Evaluation & Implementation at NASSCO

Application of Industrial Engineering Techniques to Reduce Workers Compensation and Environmental Costs

N8-96-3

Objectives

- Identify efficient methods of tracking costs and volume of hazardous and non-hazardous wastes using industrial engineering techniques
- Shift from manual tracking to computer automated process system
- Implement waste minimization techniques based on cost reduction

Objectives

- Institute a network system accessible by shipyard departments
- Track all hazardous waste generators within shipyard
- Provide database for inventory reports for the management and environmental regulatory agencies

Deliverable

- Written report on selection and implementation of the tracking software system

Software Selection Criteria

- Allow to track waste activities from generation to disposal
- Allow easy and efficient tracking of waste containers
- Ability to allocate waste volume and disposal costs to each generating department
- Ability to integrate all related data into one program

Software Selection Criteria

- Ability to track and maintain current and archived data
- Ability to generate reports for regulatory agencies
- Inexpensive
- User friendly
- Run on IBM based computer systems

Wixel ExecuTrax

- NASSCO purchased the multi-user license for $5,100
- NASSCO also purchased the technical support contract for $1,100 annually

Wixel Hardware Requirements

- PC (386 or greater)
- 4MB RAM (8MB recommended)
- 20MB available hard drive space
- Windows 3.1 or greater
- VGA Color Monitor
- Mouse

Projected Benefits

- Reduction in the biennial hazardous waste report preparation time
  - 80 Hours to 8 Hours (approx.)
- Ease of hazardous waste generator fee and tax calculation
- Increased efficiency of the waste management information tracking
- Ability to integrate into an environmental management system

DELIVERABLE K

FINAL REPORT

PROJECT ENGINEER RECOMMENDATIONS

Project Engineer Recommendations

The processes and procedures used by these process improvement teams, (Steel Erection, Electrical, Paint and Blast) represent a base model for reducing workers compensation and occupational injuries. There is a wealth of research and information available to the industry from sources such as, OSHA, Council on Ergonomic and Management, and other governmental and private health organizations, to reduce injuries. Some of the information, research, and recommendations contained in these reports, were utilized during this project to help reduce or prevent further occurrence of injuries and workers compensation cost.

What makes this research project different from conventional projects is this; the employees, who actually perform the work, are the individuals involved in the problem solving process. When an organization is committed to reducing injuries and providing a safe environment, buy-in at the lowest employee level can be attained. The success of a business enterprise in the 1990's requires empowering employees to take responsible and accountable actions to assure personal safety on the job. This may sound like the "antiquated" expressions, "the employees are at fault", or "it is human nature", or "they are resistant to change." Quite contrary, management has to put in place, the proper tools, proper training, instill a culture change by living example and most importantly, be a learning organization committed to change. Once the employees are equipped, job performance in a safe, responsible and accountable manner is possible.

In order to reduce injuries and workers compensation costs in our shipyards, I believe that three basic domains should be examined: the environment (including tools, equipment, and climate of work setting), the person (including attitudes, beliefs, and personalities of the employees) and behavior (including safe and at-risk work practices, as well as intervening for a coworkers safety. These factors are interactive, dynamic, and reciprocal; influencing one factor eventually has impact on the other two. For example, changes in the environment have indirect effects on people's behaviors and attitudes, and behavior change usually results in some change in the environment. Thus, a Total Safety Culture (E.Geller 1997) must address each of these domains during the development and implementation of intervention strategies and throughout the ongoing evaluation and refinement of each process for achieving a Total Safety Culture. Each employee, whether CEO, Manager, Supervisor, or President has the right to return home in the same physical condition they came to work in.

Internal (observable) personnel factors continually influence observable behaviors, while changes in observable behaviors continually affect changes in person factors. Thus, it's possible to educate a person into safe behaviors (e.g., through education, coaching, and consensus building exercises), and it's possible to train

a person into safe thinking (e.g., through behavior management techniques). In an industrial setting, it is most cost-effective to target behaviors directly through behavior management interventions (e.g., behavior prompts, feedback, and rewards) implemented by the employees themselves. Small changes in behavior can result in attitude change, followed by more behavior change and more desired attitude change. This spiraling of behavior feeding attitude, feeding behaviors, feeding attitudes (and so on) can lead to employees becoming totally committed to a total safety culture, as reflected in their daily behaviors. And all of this could start with a relatively insignificant behavior change in one employee, a small win.

Intervention agents are needed to initiate increases in safe behavior throughout an organization and to nurture these small wins into a total safety culture. In other words, a total safety culture requires that employees accept responsibility of intervening for the safety of both themselves and others. In fact, in a total safety culture all employees look for ways to make behavior and environmental conditions safer; and when they find one, they intervene with appropriate consideration of relevant person factors. Thus, in a total safety culture all employees are continually involved in the safety process. In other words, all employees "actively care" for the achievement of a total safety culture.

Other concepts such as, communication, team building, and training in the total organizational culture will determine a successful safety program. Many organizations carry one or more of these concepts in their Vision, Mission and Goal statements, but are these concepts really understood in the context of safety? In my recommendations I will identify and define each individual concept in their context of organizational culture. After being apart of the individual process improvement teams, I've noticed a sub-culture that operates within the vision, mission and goals of the company. All organizations possess some form and shape of culture, and in some cases, there may be more than one culture in existence. Organization culture is sometimes difficult to define, and even more difficult to assess, measure and, if needed, to change. These observations were based on **historical methodology** to determine past practices of problem solving, teambuilding, and overall concern and values and attitudes of the personnel.

The remainder of the my recommendations will focus on the following concepts:

A. Communication

B. Problem Solving In-Groups: When and Why

C. Organizational culture

D. Three cultures of management

A. COMMUNICATION

The term communication is broad in that, people use it in a variety of ways that are only vaguely related. Family members, business entities, scientist, and certain organizations use the term differently but there is clearly some relationship among the uses of the word. A survey of the ways in which scholars use the word will show that there is no single, universally accepted usage. Some definitions are long and complex, others are brief and simple. What I am going to give is a working definition that will help achieve results for process improvement teams. For the purposes of this report **communication** *refers to the process of human beings responding to the face-to-face symbolic behavior of other persons.*

Communication is a Process

We often talk about communication as if it occurred in discrete, individual acts. In fact, communication is a continuous, ongoing process. Consider, for example, a friend's compliment about your appearance. Your interpretation of those words will depend on a long series of experiences stretching far back in time: How have others judged your appearance? How do you feel about your looks? How honest has your friend been in the past? How have you been feeling about one another recently? All this history will help shape your response to the other person's remark. In turn, the words you speak and the way you say them will shape the way your friend behaves towards you and others- both in this situation and the future. My point here is that, not only the words you speak but, your attitude towards your employees will determine the success or failure of your team.

This simple example shows that it's accurate to talk about "acts" of communication as if they occurred in isolation. To put it differently, communication isn't a series of incidents pasted together like photographs in a scrapbook; instead, it is more like a motion picture in which the meaning comes from the unfolding of an interrelated series of images.

Communication Competence

It's easy to recognize good communicators, and even easier to spot poor ones. Lee Ioccoa, past CEO of Chrysler Corporation, was able to revive that corporation from bankruptcy, not because of leadership skills alone but with effective communication skills. The characteristic that distinguishes effective communicators from their less successful counterparts is **communication competence.** Most communication experts agree that communication competence is the ability to get what you seek from others in a manner that maintains the relationship on terms acceptable to both you and the other person. Ideally, an effective team will display communication

competence in results, relationships, and overall team interaction with other groups. The definition may seem both vague and verbose, but a closer look shows that it suggests several important characteristics of communication competence.
Your own experience shows that a variety of communication styles can be effective. Some very successful people are serious, while others use humor; some are gregarious, while others are quiet; and some are straightforward, while others hint diplomatically. Just as there are many kinds of beautiful music and art, there are many kinds of competent communication.

Because competent behavior varies so much from one situation and person to another, it is a mistake to think that communication competence is a trait that a person either possesses or lacks. It's more accurate to talk about degrees or areas of competence. In order for teams to be successful in meeting challenges and performing tasks, their degree of communication competence must be consistently improved.

There are two sets of communications skills that any group must possess in order to come up with successful solutions. The first has to do with the group task itself: how to analyze the problem, choose the best solution, and make it work. A second area involves building and maintaining good relationships: making sure, first, that members feel good about each other and second, that they enjoy the experience of working together.

B. PROBLEM-SOLVING IN GROUPS: WHY AND WHEN

To many people, groups are to communication what Twinkies are to food, a joke. This unflattering reputation is at least partly justified. Most of us would wind up with a handsome sum if we had a dollar for every hour wasted in-group. On the other hand, it's unfair to view all groups as bad, especially when this accusation implies that other types of communication are by nature superior. Is group problem solving a waste of effort, or is it the best way to manage a task? As with most matters the truth falls somewhere between these two extremes. Groups do have their shortcomings, which will be discussed later.

1. Advantages of Group Problem-Solving

Research over fifty years that has compared problem-solving by groups and by individuals shows that, in most cases, groups can produce more solutions to a problem than individuals working alone...and that the solutions will be of higher quality. Groups have proved superior at a wide range of tasks, everything from assembling jigsaw puzzles to solving complex reasoning problems. There are several reasons why groups are effective.

a. **Resources:** For many tasks, groups possess a greater collection of resources than do most individuals. Sometimes the resources are physical. For example, three or four people can put up a tent or dig a ditch better than a lone person. But on other problems the pooled resources lead to qualitatively better solutions. Think, for instance, about times when you have studied with other students for a test, and you will remember how much better the group was at preparing for all the questions that might be asked and at developing answers to them. (This, of course, assumes that the study group members cared enough about the exam to have studied for it before the group meeting.) Groups not only have more resources than individuals; through interaction among the members they also are better able to mobilize them. Talking about an upcoming test with others can jog your memory about items you might not have thought of if you had been working alone.

b. **Accuracy:** Another benefit of group work is the increased likelihood of catching errors. At one time or another, we all make mistakes, like the man who built a boat in his basement and then wasn't able to get it out the door. Working in a group increases the chance that foolish errors like this won't slip by. Sometimes, of course, errors aren't so obvious, which makes groups even more valuable as an error-checking mechanism. Another side to the error-detecting story is the risk that group members will support each other in a bad idea.

c. **Commitment:** Besides coming up with superior solutions, groups also generate higher commitment to carrying them out. Members are most likely to accept solutions they have helped create, and they will work harder to carry out those actions. This fact has led to the principle of participative decision making, in which the people who live with a plan help make it. This is an especially important principle for those in authority such as supervisors, teachers, and parents. As supervisors, we have seen the difference between the sullen compliance of employees who have been forced to accept a new procedure in which they disagree and the much willing cooperation of work groups who have helped to develop it. Though the benefits of participative decision making are great, I need to insert a qualification here: There are times when an autocratic approach of imposing a decision without discussion is most effective.

2. When to Use Groups for Problem-Solving

Despite their advantages, groups aren't always the best way to solve a problem. Many jobs can be tackled more quickly and easily-even more efficiently by one or more people working independently. Answering the following questions will help you decide when to solve a problem using a group, and when to tackle it alone.

a. **Is the job Beyond the Capacity of One Person?** Some jobs are simply too big for one person to manage. They may call for more information than a single person possesses or can gather. Some jobs also require more time and energy than one person can spare. It's both unrealistic and unfair to expect one or two people to do all this work.

b. **Is individuals' Tasks Interdependent?** Remember that a group is more than a collection of individuals working side by side. The best tasks for groups are ones where the individuals can help one another in some way. Think of a group of disgruntled renters considering how to protest unfair landlords. In order to get anywhere, they realize that they have to assign areas of responsibility to each member: researching the law, seeking additional members, publicizing their complaint, and so on. It's easy to see that these jobs are interdependent.

   Even when everyone is working on the same job, there can be interdependence if different members fulfill the various functional roles. Some people might be better at task-related roles like information giving, diagnosing, and summarizing. Others might contribute by filling social roles such as harmonizing, supporting, or relieving tension. People working independently simply don't have the breadth of resources to fill all these functions.

c. **Is There More Than One Decision or Solution?** Groups are best suited to tackling problems that have no single, cut-and-dried answer: What's the best way to boost membership in a professional organization? How can funds be raised for a charity? What topic should the group choose for a class project? Gaining the perspectives of every member boosts the odds of finding high quality answers to questions like these.

   By contrast, a problem with only one solution won't take full advantage of a group's talents. For example, phoning merchants to get price quotes or looking up a series of books in a library don't require much creative thinking. One or two people working alone can

handle jobs like these. Of course, it may take a group meeting to decide how to divide the work to get the job done most efficiently.

d. **Is There Potential for Disagreement?** Tackling problems as a group is essential if you need the support of everyone involved. Consider a group of friends planning a trip. Letting one or two people choose the destination, schedule, and budget would be asking for trouble, since their decisions would almost certainly disappoint at least some the people who weren't consulted. It would be smarter to involve everyone in most important decisions, even if doing so took more time. Once key decisions were settled, it might be fine to delegate relatively minor issues to one or two people.

C. ORGANIZATIONAL CULTURE

For the purpose of this research project, I will give a detailed analysis on why organizational culture should be assessed before undertaking team building and problem-solving groups. When injuries escalate and workers' compensation cost rise, management often initiates new programs, procedures and rewards (the new flavor of the month) to lower costs and personnel injuries. Yet, we wonder why after a few months, the injuries and compensation costs rise again. In many instances employee turnover, new technology, new processes and procedures are contributing factors to an organization returning to past failures. There can be a false assumption that the "employees are maybe out of control" or they are just "careless." What actually happens is that the organization fails to continue to use it's new learning.

The ability to create new organizational forms and processes, to innovate both in technical and organizational arenas, is crucial to remaining competitive in an increasingly turbulent world. But this kind of organizational learning requires not only the invention of new forms, but their adoption and their diffusion to the other relevant parts of the organization. Organizations still have not learned how to manage that process. The examples of successful organizational learning I've seen either tend to be short-run adaptive learning, doing better at what we are already doing, or, if they are genuine innovations, they tend to be isolated and eventually subverted or abandoned.

The history of organizational development, change, innovation and learning shows over and over again that certain lessons seem not to take hold. As early as the Hawthorne studies of the 1920's it was recognized that employee involvement increased both productivity and motivation. Lewin, Argyris, McGregor, Likert, and many others showed managers who treated people as adults, who involved them appropriately in the task they were accountable for, who created conditions that allowed employees to obtain good feedback so that they could monitor their own performance were more effective than those who did not.

On the one hand, one can say that this is just normal life in organizations. It is just politics or just human nature. Or one can say that these projects and programs were mismanaged, either by the project teams or the executive management above them. Or one can say that all of these human relations oriented programs were misguided in the first place. The deeper issue is that we have in most organizations three different major occupational cultures that do not really understand each other very well and that often work at cross-purposes with each other. These cultures cut across organizations and are based on what have been described as "occupational communities"(Van Maanen & Barley, 1984).
(See section on the concept of culture and occupational communities).

1. What is Organizational Culture?

The review of literature to support this project provided for some interesting theories and philosophies in regards to the concept of organizational culture. The intent of the review of the literature was to gain as much knowledge and insight as possible to assist in my own understanding of the concept of organizational culture. This is necessary in order to determine the methodology for developing a working definition of organizational culture.

The working definition is built on the idea that the two principal types of assumptions that form any culture are shared beliefs and shared values. The content of the culture is ultimately derived from two principal sources; the first being the assumptions that leaders, managers, and employees bring with them to the organization, and the second being from the actual experience from the people within the organization as the adapt to the internal and external environments. The ability to define and label culture is difficult and requires the use of evidence, both historical and current, to infer what the culture is.

Charles Hampden-Turner provides a definition in his book, Creating Corporate Culture: From Discord to Harmony (1992), which provides insight to the overall idea and concern of culture, and assists in the building of a working definition for this project.

> Culture comes from within people and is put together by them to reward the capacities that they have in common. Culture gives continuity and identity to the group. It balances contrasting contributions and operates as a self-steering system that learns from feedback. It works as a pattern of information and can greatly facilitate the exchange of understanding. The Values with a culture are more or less harmonious (Hampden-Turner, 1992).

Edgar H.Schien, MIT Sloan School of Management, provides another definition in the periodical titled, The Key to Organizational Learning in the 21st Century (1997).

> A culture is a set of basic tacit assumptions about how the world is and ought to be that is shared by a set of people and determines their perceptions, thoughts, feelings and, to some degree, their overt behavior of people and determines their perceptions, thoughts, feelings and, to some degree, their overt behavior. Culture manifests itself at three levels, the level of the deep tacit assumption that are

the essence of the culture, the level of espoused values which often reflect what a group wishes to be ideally and the way it wants to present itself publicly, and the day to day behavior which represents a complex compromise between the espoused values, the deeper assumptions and the immediate requirements of the situation. Overt behavior alone cannot be used to decipher culture because situational contingencies often make us behave in a manner inconsistent with our deeper values and assumptions. It is for this reason that one often sees "inconsistencies" or "conflicts" in overt behavior or between and espoused values. To get at the basic elements of culture one must either observe behavior over a long period of time or get directly at the underlying values and assumptions that drive the perceptions and thoughts of the group members.

For example, many organizations espouse "team work" and "cooperation," but the behavior that is rewarded and encouraged by the incentive and control systems of the organization is based more on a shared tacit assumption that only individuals can be accountable and that the best results will come from a system of individual competition and rewards. If the external situation demands teamwork the group will develop some behavior that looks on the surface like teamwork by conducting meetings and seeking consensus, but members will continue to share the belief that one gets ahead by individual effort and will act accordingly when rewards are given out. Many executives tell their subordinates that they expect them to act as a team but remind them in the same sentence that they are competing for the boss's job!

2. Procedures to Analyze Organizational Culture

Review of the above-mentioned books pointed out that organizational culture couldn't be easily measured, observed, and defined. Therefore, it is my suggestion to utilize both historical and descriptive methodologies of research in order to obtain both qualitative and quantitative aggregate data. Historical research involves the studying, understanding, and explaining of past events in order to arrive at conclusions about causes, effects, and trends of past events. This can help researchers in understanding and explaining present events and to also anticipate future events. Two of the principal types of assumptions, which form a culture, are shared beliefs and shared values. What has to be measured is not what the person says his/her beliefs and values are, but what his/her actions exhibit.

Culture is subject to development and change over a period of time because of the learning going on within the organization. This change is normally incremental and evolutionary and is affected by both external and internal environmental factors. The importance is in understanding the assumptions that leaders, managers, employees have brought with them and determining how these assumptions have had an impact on the development of the present culture. It is also important to determine the actual experience from people within the organization in their adapting to the internal and external environments.

In conducting the historical research, the main emphasis is determining how the culture is embedded in the organization and what significant events may have led to significant changes in the organizational culture. The evolution of the organization to how it exist now may give insight to the culture. Conflicts between leaders, union, and management as well as changes in organizational philosophy will all have an effect on the people within the organization. The researcher must determine how the organization is designed and structured for its decision making and communication flow. It is also important to determine how the organization response to crisis and other critical events and what has been learned from these experiences. This historical research will provide a basis upon which to build an understanding of the culture, and why it exists as it does today.

The descriptive research method is used to gather information on determining and reporting on the present status of the culture. The purpose is to clarify and report on the way things are now. This process can involve assessing attitudes and/or opinions. The problem with measuring feelings and attitudes is that they are highly changeable. In reacting to day-to-day events a person may be content one day and highly agitated and disagreeable the next.

An excellent instrument to measure how much of something is present and not feelings, or likes and dislikes, is the Survey of Organizations (SOO-2000). It is developed and provided by Renis Likert Associates, Inc. The main purpose of the instrument is to measure characteristics of the organizational climate, managerial leadership, peer behavior, satisfaction, and group process. This provides a descriptive measure of the prevailing conditions as perceived by the members of the organization.

The survey examines four categories of the organization. It measures the overall Organizational Culture, which deals with the organization-wide conditions, policies, and practices. The second category is Supervisory-

leadership, which relates to the interpersonal and task-related behaviors displayed by superiors towards their subordinates. The Peer Relationships are a measure of the interpersonal and task-related behaviors of the work group. The final category is a measure of the way the group works together as a team. This becomes an overall measure of the organization as summarized in the end results.

There is substantiating evidence that every organization has some type of culture. That culture represents a set of shared values and beliefs, which form a set of customs and typical patterns. It is assumed that an organization that has any history at all has developed some sort of culture and that this will have a vital impact on the degree of success of any efforts to alter or improve the organization.

The study of organizational culture provides a definition of a pattern of basic assumptions--invested, discovered, or developed by a given group as it learns to cope with its problems of external adaptation and internal integration--that has worked well enough to be considered valid and, therefore, to be taught to new members as the correct way to perceive, think, and feel in relation to these problems. The culture then becomes a major factor in determining the behaviors or actions by letting people know what is acceptable and what is not acceptable. These patterns of basic assumptions then become viewed as a set of understandings or meanings shared by that group of people. This definition then lends validity to the fact that many other organizational components, other than just employee attitudes, must also be considered in any assessment of the organization as whole.

To get a truly comprehensive picture of a department's culture, the following organizational components must be assessed.

1. The basic organizational beliefs, expectations, and shared values that set the environment for quality of service provided.

2. The group relations in regards to openness and trust among department members.

3. The history of the organization's growth and development, with emphasis on folklore, and stories of past events.

4. The leadership styles throughout the organization, and how

leadership is shared and promoted.

5. The lines of communication through the organization, with emphasis on free, creative, and effective communication of ideas.

6. The task of commitment, with goals and objectives clearly defined, with evidence of commitment to support and achieve them.

7. The reward system that recognizes challenging work combined with a system that adequately rewards persons for their efforts and achievements.

8. The spirit of cooperation which may exist between individuals and among the various parts of the department, with special emphasis on teamwork.

3. Cultures and Sub-Cultures

Cultures in this sense arise within *organizations* based on their own histories and experiences. Starting with the founders, those members of the organization who have shared in the successful growth of an organization will have developed a set of assumptions about the world and how to succeed in it, and will have taught those assumptions to new members of the organization.

Shared assumptions also typically form around the functional units of the organization. They are often based on similarity of educational background in the members or a similarity of organizational experience. What we often end up calling "stove pipes" or "silos." We all know that getting cross-functional project teams to work well together is difficult because the members bring their functional cultures into the project and, and as a consequence, have difficulty communicating with each other, reaching consensus, and implementing decisions in an effective manner. The difficulties of communication across boundaries arise not only from the fact that the functional groups have different goals, but also from the more fundamental issue that the very meaning of the words they use will differ. The word "marketing" will mean product development to the engineer, studying customers through market research to the product manager, merchandising to the salesman, and constant change in the design to the manufacturing manager. When they try to work together they will often

attribute disagreement to personalities and fail to notice the deeper shared assumptions that color how each function thinks.

Another kind of sub-culture, less often acknowledged, reflects the common experiences of given levels within a hierarchy. Culture arises through shared experiences of success. If first line supervisors discover ways of managing their subordinates that are consistently successful, they will gradually build up a set of shared assumptions about how to do their job that can be thought of as the "culture of first line supervision." In the same way middle management and higher levels will develop their own shared assumptions, and, at each level, those assumptions will be taught to newcomers as they get promoted into that level. It is these hierarchically based cultures that create the communication problems associated with "selling senior management on a new way of doing things," or "getting budget approval for a new piece of equipment." As each cultural boundary is crossed, the proposal has to be put into the appropriate language for the next higher level, and has to reflect the values and assumptions of that higher level. Or, from the point of view of the higher levels, decisions have to be put into a form that lower levels can understand, often resulting in "translations" that actually distort and sometimes even subvert what the higher levels wanted.

Occupational communities also generate cultures that cut across organizations (Van Maanen &Barley, 1984). For example, fishermen around the world develop similar worldviews, as do miners, and, as do the members of a particular industry based on a particular technology. In these cases the shared assumptions derive from a common educational background, the requirements of a given occupation such as the licenses that have to be obtained to practice, and shared contact with others in the occupation.

The learning problems that are identified above can be directly related to the lack of alignment between three cultures, two of which are based on occupational communities. 1). *The culture of engineering.* 2). *The culture of CEO's.* 3). *The culture of operators.* The shared assumptions that arise in the "line units" of a given organization as it attempt to operate efficiently and safely. In order to understand how these cultures interact, let’s examine their shared assumptions.

D. Three Cultures of Management

The Operator Culture. This culture is most difficult to describe because it evolves locally in organizations and within operational units. Thus one can identify and operator culture in the office, in the auto plant, in the cockpit, in the chemical complex, but it is not clear what elements make this culture broader than the local unit. To get at this issue we must consider that the operations in different industries reflect the broad technological trends in those industries. At some fundamental level, how one do things in a given industry reflects the core technologies that created that industry. And as those technologies themselves evolve, the nature of operations changes. For example, as Zuboff (1988) has persuasively argued, information technology has made manual labor obsolete in many industries and replaced it with conceptual tasks. In a chemical plant the worker no longer walks around observing, smelling, touching and manipulating. Instead he or she sits in a control room and infers the conditions in the plant from the various indexes that come up on the computer screen.

The operator culture is based on human interaction and most line units learn that high level of communication, trust and teamwork are essential to getting the work done efficiently. Operators also learn that no matter how clearly the rules are specified of what is supposed to be done under different operational conditions, the world is to some degree unpredictable and one must be prepared to use one's owne's innovative skills to deal with them. Rules and hierarchy often get in the way under unpredicted conditions. Operators become highly sensitive to the degree to which the production process is a system of interdependent functions all of which must work together in order to be efficient and effective. These points apply to all kinds of "production processes" whether we are talking about a sales function, a clerical group or a service unit.

The tragedy of most organizations is that the operators know that to get the job done effectively they must adhere to the assumptions stated above, but the incentitive system nor the day to day management system may support those assumptions. Operators thus learn to subvert what they know to be true and "work to rule," or use their learning ability to thwart management's efforts to improve productivity. In order to understand why this happens we must examine how two other major cultures operate in organizations.

The Engineering Culture. In all organizations there is a group that represents the basic design elements of the technology underlying the work of the organization and has the knowledge of how that technology is to be utilized. This occupational community cuts across nations and industries and can best be labeled the "engineering culture" (Kunda, 1992). Though this culture is most visible in traditional engineering functions one can see it in operation equally in the designers

and implementers of all kinds of technologies, information technology, market research, financial systems, and so on. The shared assumptions of this community are based on common education, work experience and the requirements of their job.

Engineers and technocrats of all persuasions are attracted to engineering in the first place because it is abstract and impersonal. Their education reinforces the view that problems have abstract solutions and those solutions can, in principle, be implemented in the real world with products and systems that are free of human errors. Engineers, and I am using this term in the broadest sense, are designers of products and systems that have utility, elegance, efficiency, safety, and maybe, as in the case of architecture, even aesthetic appeal, but they are basically designed to required standard responses from their human operators, or, ideally, to have no human operators at all.

In the design of complex systems, the engineer prefers a technical routine to insure safety rather than relying on a human team to manage the contingencies that might arise. Engineers recognize the human factor and design for it, but their preference is to make things as automatic as possible. Safety is built into the designs themselves. In other words, one of the key themes in the culture of engineering is the pre-occupation with designing humans out of the systems rather than into them.

Both the operators and the engineers often find themselves out of alignment with a third critical culture, the culture of the executives.

The Executive Culture. The third culture to be explored is the "executive culture," the set of shared tacit assumptions that CEO's and their immediate subordinates share worldwide. This executive worldview is built around the necessity to maintain the financial health of the organization and is fed by the pre-occupations of boards, of investors, and of the capital markets. Whatever other pre-occupations executives may have, they cannot get away from having to worry about and manage financial issues of the survival and growth of their organization (Donaldson & Lorsch, 1983).

What's being identified as the executive culture applies particularly to CEO's who have risen through the ranks and have been promoted to their jobs. Founders of organizations or family members who have been appointed to these levels exhibit different kinds of assumptions and often can maintain a broader focus (Schein, 1983). It is especially the promoted CEO who adapts the exclusively financial point of view because of the nature of the executive career. As managers rise higher and higher in the hierarchy, as their level of responsibility and accountability grows, they not only have to become more pre-occupied with financial matters, but they also

discover that it becomes harder and harder to manage to observe and influence the basic work of the organization. They discover that they have to manage at a distance and that discovery inevitably forces them to think in terms of control systems and routines which become increasingly impersonal. Because accountability is always centralized and flows to the tops of organizations, executives feel and increasing need to know what is going on while recognizing that it is harder and harder to get reliable information. That need for information and control drives them to develop elaborated information systems alongside the control systems and to feel increasingly alone in their position atop the hierarchy.

Paradoxically, throughout their career managers have to deal with people and surely recognize intellectually that it is people who ultimately make the organization run. First line supervisors, especially, know very well how dependent they are on people. However, as managers rise in the hierarchy, two factors cause them to become more "impersonal." First, they become increasingly aware that they are no longer managing operators, but other managers who think like they do, thus making it not only possible but likely that their thought patterns and world view will increasingly diverge from the world view of the operators. Second, as they rise, the units they manage grow larger and larger until it becomes impossible to know everyone personally who works for them. At some point they recognize that they cannot manage all the people directly and, therefore, have to develop systems, routines, and rules to manage "the organization." People increasingly come to be viewed as "human resources" and are treated as a cost rather than a capital investment.

The executive culture thus has in common with the engineering culture a predilection to see people as an impersonal resource that generate problems rather than solutions. Or, another way to put this point is to note that both executive culture and engineering culture view people and relationships as means to the end of efficiency and productivity, not as ends in themselves. If one must have human operators, so be it, but let's minimize their possible impact on the operations and their cost to the enterprise.

1. Interactions Among the Three Cultures

In many industries there is enough initial alignment between the needs of the task as defined by the operators, the needs of the engineers for reliable and efficient operations, and the needs of the executives for minimizing costs and maximizing profits so we do not observe any problems. It is when organizations learn generationally, when they attempt to reinvent themselves because the technologies and environmental conditions have changed drastically that these three cultures collide and we observe frustration, low productivity, and the failure of innovations to survive, therefore they diffuse.

The lack of alignment between the executive, the engineering and the operator culture can be seen in other industries such as health care where the needs of the primary care physicians (the operators) to do health maintenance and illness prevention runs both into the engineering desire to save life at all costs and the executive desire to minimize costs no matter how this might constrain either the engineers or the operators.

In the educational world we see the same conflict between teachers who value the human interaction with students and the proponents of sophisticated computerized educational systems on the one hand and the cost constraints imposed by school administrators on the other. If the engineers win, money is spent on computers and technologically sophisticated classrooms. If the administrators win, classes become larger and undermine the classroom climate. In either case, the operators, the teachers lose out and human innovations in learning are lost.

It is important to note that each of the three cultures is from its point of view "valid", in the sense of doing what it is suppose to do. Executives are supposed to worry about the financial health of their organization and engineers are supposed to innovate toward the most creative people free solutions. To create alignment between these three cultures, then, is not a case of deciding which one has the right point of view, but of crating enough mutual understanding between them to evolve solutions that will be understood and implemented. Too often in today's organizational world either the operators assume that the executives and engineers don't understand so they resist and covertly do things their own way, or executives and /or engineers assume that the operators need to be controlled more tightly and be forced to follow policies and manuals of procedure. In either case effectiveness or efficiency will suffer because there is no common plan that everyone can understand and commit to.

Another point to note is that both executive and engineering culture are

primarily task focused and operate on the implicit assumption that people are the problem, either as costs or as sources of error. In the case of the engineering culture the assumption is already in their education and training. The ultimately elegant solution is one that always works and works automatically, in other words, with out human intervention. In the case of the executive culture the situation is more complex. Executives either have come from the engineering culture where people were not important in the first place or learned as they rose and began to feel responsible for hundreds and thousands of people that they had to think in terms of systems, routines, rules, and abstract processes for organizing, motivating, and controlling. And as they become chief executives accountable to the financial markets and their stockholders they learn to focus more and more on the financial aspects of the organization. The gradual depersonalization of the organization and the perception that employees are mostly a cost instead of a capital investment is thus a learned occupational response.

The engineering and executive cultures may agree on the assumption that people are a problem, but they disagree completely on how to make organizations work more effectively. Executives recognize that their world is one of imperfect information, of constant change, and of short-run coping while attempting to maintain strategic focus. Engineers seek elegant permanent solution that are guaranteed to work and be safe under all circumstances, and, therefore, typically produce solutions that cost much more than the executives believe they can afford. So the executives and the engineers are in a constant battle of how good is good enough and how to keep costs down enough to remain competitive.

What is most problematic in this kind of scenario is that we have come to accept the conflict between engineering and management as normal, leading members of each culture to devalue the concerns of the other culture rather than looking for integrative solutions that will benefit both. And those executives who realize this dilemma tend to involve themselves from time to time in operations and in product development so that they do not lose touch with realities and strengths of the other cultures.

2. LEARNING IN THE TWENTY-FIRST CENTURY

It is of my belief that, organizations will not learn effectively until we recognize and confront the implications of the three cultures emphasized. Until executives, engineers, and operators discover that they use different languages, make different assumptions about what is important and until they learn to treat the other cultures as valid and normal, we will continue to

see failures in organizational learning efforts. We will see powerful innovations at the operator level that are ignored, subverted or actually punished, we will see technologies that are grossly under-utilized, we will see angry employees railing against the impersonal programs of re-engineering and down-sizing, we will see frustrated executives who know what they want to accomplish but feel impotent in pushing their ideas through complex human systems, and we will see frustrated academics wondering why certain ideas like employee involvement, socio-technical systems analyses, high commitment organizations, and concepts of social responsibility continue to be ignored, only to be reinvented under some other label a few decades later.

First, we must take the concept of culture more seriously than we have. Instead of fooling around with superficial notions of manipulating a few priorities and calling that "culture change," we must recognize and accept how deeply embedded the shared tacit assumptions of executives, engineers, and employees really are. After all, we live in this industrial system for a century or more and have evolved these assumptions as an effective way for dealing with our problems. Each of these cultures can justify itself historically, and each has contributed to the success of the industrial system we have evolved.

Second, we must acknowledge that one of the main consequences of technological complexity, globalism, and universal transparency is that some of the old assumptions no longer work. Neither the executives, nor the engineers alone can solve the problems that a complex socio-technical system. We will have to find ways of communication that stimulates mutual understanding rather than mutual blame.

Third, we must learn how to create such communication by learning how to conduct cross-cultural "dialogues." The concept of "dialogue" has in recent years substantially improved our understanding of human thought and communication, and promises to make it possible to gain some understanding across cultural boundaries (Isaacs, 1993; Schein, 1993). If we can get people from the different culture into the room together, which is hard enough, we must get them to reflectively listen to themselves and to each other which is even harder.
Fortunately, the understanding of what it takes to create effective dialogues is itself coming to be better understood.

We are a long way from having solved the problems of organizational learning, but I am convinced that thinking about occupational communities and the cultures of management will help the process of structuring solutions to these problems in a way that will become visible in the 21st century.

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Vendors

During the course of this Project, the recommendations and testing would not have been possible without the assistance of various vendors. The tools and materials tested during this research project have performed well under various conditions and continue to be used in different areas of production. I recommend these companies to assist your particular organization with implementing any findings of this research project. My recommendations are based on Quality, Outstanding Customer service, Cost efficiency and Professionalism. The vendors recommended are:

- **Dynabrade, Inc. (Quality Industrial Abrasive Power Tools)**
  Brian Fischer
  Regional Sales Manager
  8989 Sheridan Drive
  Clarence, New York 14031-1490
  716/631-0100 Fax. 716-631-2073

- **Clawson Container Company**
  David J. Marzinke
  6401 Warner Ave. Suite 301
  Huntington Beach, California 92647
  714/842-4749 Fax…714/842-3389

- **Safeguard Technologies**
  Manufacturers of Air Belt & Air Flex
  Greg Bauer
  Regional Sales Manager
  605 Dahlia Way
  Acworth, Ga. 30102
  404/713-2425..or 800-AIRBELT
  Fax…404/592-1806

- **Norton Company**
  Kimberly A. Watson
  Sales Representative
  Abrasive Marketing Group
  2355 San Ramon Valley Boulevard
  Suite 102
  San Ramon, CA. 94583
  619/930-9464…800/826-0455..Ext..3572
  Fax…619/930-9465…

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  Judi Coulthard, O.T.R., C.H.T
  Jeannette Barrack, Physical Therapist
  Corporate Office
  4480 30th Street
  San Diego, CA. 92116
  619/281-4900
  Fax. 619/281-0178

- **Tools and Metals, Inc.**
  Kris Sanders
  Marketing Supervisor
  1267 Vernon Way
  El Cajon, CA. 92020
  619/562-1882
  619/286-8670
  Fax…619/562-5430

- **Relco Engineers..Industrial Finishing Systems**
  Larry Nicholas
  Operations Manager
  13303 East Rosecrans Ave.
  Santa Fe Springs, CA. 90670
  562/404-7574
  Fax…562/404-1451
  San Diego, Office..619/336-2244

- **Klingspor Abrasives, Inc.**
  Dave Stephen
  Territory Manager
  800/645-5555
  Fax…800/524-6758
  Vm…800/524-8255…Ext. 8-627

- **Impacto Protective Products Inc. (Gloves Manufacturer)**
  40 Dussek Street, PO Box 524
  Belleville, Ontario
  K8N 5B2
  613/966-0062
  Tom Sabastion
  613/373-5802

- **Chicago Pneumatic Tool Company**
  2200 Becker Street
  Utica, NY..13501
  800/232-6611
  315/792-2670

- **GreenLee Textron (Cable Puller)**
  Steve Norris
  Territory Manager
  5336 Lindbergh Lane
  Bell, CA. 90201
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